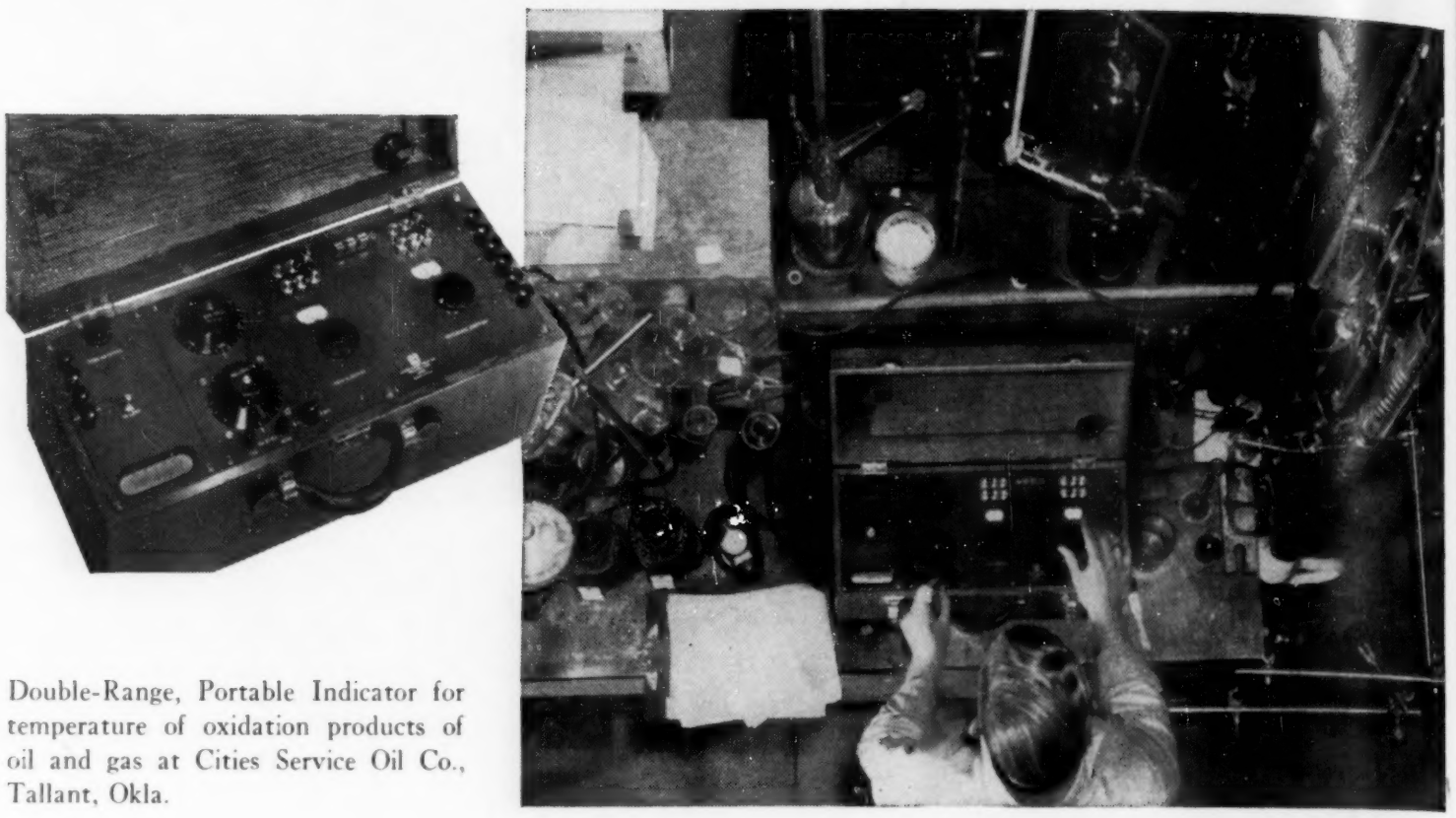
Science

Alexander Wetmore



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CONTENTS

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Nomenclature of Streptomycin Preparations[1]

Selman A. Waksman

New Jersey Agricultural Experiment Station, New Brunswick

ANTIBIOTIC SUBSTANCES ARE PRODUCTS of living systems. They are formed mostly under artificial conditions of cultivation upon complex organic or synthetic media. Methods for their isolation from the medium vary greatly. Most of the antibiotics have been named and described on the basis of crude preparations, or long before they have been isolated in a pure state and their chemical nature determined. The designations and descriptions of antibiotics are based largely upon their formation and certain important properties. These are:

(1) Origin—that is, the nature of the organisms producing them. Most of the antibiotics have been named after the genera or species of these organisms.

(2) Antibacterial or antibiotic spectrum, namely, the selective action of the antibiotic against various bacteria and other microorganisms. This is one of the most important properties of the antibiotic, since its nature and possible utilization are thus characterized. The differences in sensitivity of the various bacteria to a given antibiotic may be both qualitative and quantitative. The nature of the test medium for making the bioassays is, thus, of primary importance. Frequently, bacteria made resistant to one or more known antibiotics are used to establish the identity of an unknown substance.

(3) Toxicity of the antibiotic to animals and its *in vivo* activity. These properties are most significant from the point of view of establishing the possible chemotherapeutic utilization of the antibiotic.

(4) Chemical and physical characteristics, notably elementary composition and chemical structure. The last property is the culminating point in the identification of a new antibiotic.

Although the chemical composition of an antibiotic is frequently used for establishing its further subdivisions, if such are required, it is the biological criteria which are the most significant in describing and defining a new antibiotic. It has even been suggested (*6*) that a new antibiotic not be named or described until it has been isolated in a chemically pure state. Though this procedure would be highly desirable in principle, it has not always been followed in the past, nor would it be possible to bind all investigators to its observance. Thus, penicillin and streptomycin were named, described, and even used for therapeutic purposes long before they were crystallized and their chemical nature established.

An illustration of how the above criteria apply to the isolation of a single antibiotic is provided by the data presented in the announcement of the isolation of streptomycin (*8*): (1) The organism producing this antibiotic was identified as *Streptomyces griseus*; the generic name of the organism contributed to the naming of the antibiotic. (2) Streptomycin was found to be active against various gram-negative and gram-positive bacteria, including *Mycobacterium tuberculosis*. Compared to streptothricin, a closely related antibiotic, it was much more active against certain bacteria, notably *Bacillus mycoides* and *Serratia marcescens*. (3) Streptomycin was found to have little toxicity to animals and was active *in vivo*. (4) It was isolated from the culture filtrate of *S. griseus* by the method previously developed for the isolation of streptothricin, namely, adsorption on Norite A, elution with acid-alcohol, neutralization of the acid, and removal of the alcohol. Further details of the production of the substance, its *in vitro* and *in vivo* activity, and purification procedures were reported in subsequent papers (*9*).

More recent studies of the nature of the antibiotic produced by *S. griseus* brought out two important facts: (a) the organism produces, in addition to streptomycin, two and possibly three or more antibiotics: one is present in the mycelium, and another, designated as "actidione," is found in the culture filtrate and is active only against fungi; (b) streptomycin itself, as originally defined on the basis of biological and certain chemical criteria, is not a single chemical entity, but a mixture of at least two chemically related substances. The major constituent of this mixture is undoubtedly the substance which is now known, from the degradation studies, to possess the structure of an o-glycoside of the disaccharide streptobiosamine (N-methyl-L-glucosaminido-streptose) with streptidine (1,3-diguanido-2,4,5,6-tetrahydroxycyclohexane) (*5*). The only other representative of this type which has been isolated in pure form and chemically characterized is streptomycin B (*2*); it always seems to occur in association with the previous compound, and differs

[1] Journal Series Paper, New Jersey Agricultural Experiment Station, Rutgers University, Department of Microbiology.

The contents of this paper were discussed with O. Wintersteiner, of the Squibb Institute, K. Folkers, of Merck & Co., H. E. Carter, of the University of Illinois, and M. L. Wolfrom, of Ohio State University, who have made a number of constructive suggestions and corrections.

from it by the presence of an additional D-mannose moiety in the molecule (*1*). Streptomycin B is characterized by an antibiotic spectrum (*7*) which differs quantitatively from that of the pure chemical entity originally isolated.

Thus, the elucidation of the nature of the "streptomycin complex" presents a close parallel to the advances in our knowledge of the "penicillin complex." *Penicillium notatum* and *P. chrysogenum* produce, in addition to penicillin, another, chemically unrelated antibiotic possessing entirely different antibacterial properties (penatin, notatin). Penicillin itself, even in the crystalline state, may be composed of several chemically closely related substances (F,dihydro-F,G,X,K). As a further analogy to penicillin, crude streptomycin preparations contain impurities, some of which may act as "enhancement factors" (*3*).

It need hardly be emphasized that the isolation of several chemical entities from the "streptomycin complex" introduces considerable uncertainty in the interpretation of data obtained with impure preparations containing both of the above compounds in unknown proportions; this is true especially in the correlation of chemical with biological assay data and of *in vitro* activities with therapeutic and toxicity effects in animals.

Pending the establishment and acceptance of reliable biological and chemical differential assay methods for the determination of the various compounds in mixtures, it would seem desirable to reach an agreement at least on the definition and naming of the antibiotically active materials and entities concerned. It is suggested, therefore, that the following nomenclature be adopted for products possessing streptomycin activity:

Streptomycin complex. This term should be used, in a sense originally proposed for streptomycin (*8*), to designate that group of antibiotics which is characterized by the antibacterial spectrum and certain chemical and physical properties assigned to it. This term would, therefore, have to be applied to all crude or partly purified preparations containing various forms of streptomycin and inactive impurities in unknown proportions.

Streptomycin. This term designates the compound, chemically defined as N-methyl-L-glucosaminido-streptosido-streptidine. Accordingly, the term "streptomycin A," which has been suggested for this entity by implications (*2*), is not to be used.

Mannosidostreptomycin. This term designates the entity formerly named streptomycin B and now chemically defined as D-mannosido-N-methyl-L-glucosaminido-streptosido-streptidine.[2]

Streptomycin residue. It is suggested that this term be applied to any residues which exist after the removal of highly purified streptomycin from impure streptomycin preparations and which may either have inherent antibiotic properties or act as enhancement factors.

Streptomycin-like substances. Any preparations, produced by organisms other than *Streptomyces griseus*, which show an antibiotic spectrum and other biological and chemical properties similar to those of streptomycin should be so designated. When they are crystallized and their chemical composition is determined, their exact nature may be established. This is true, for example, of streptomycin II (*4*).

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[2] Though the Squibb investigators concerned (Fried, Stavely, Titus, and Wintersteiner) took exception to the system of nomenclature here proposed, they cooperated by suggesting the new term "mannosidostreptomycin" and by agreeing to use it henceforth in their publications. The correctness of the structure given above and implied in the new term will be evident from data soon to be published in a paper by Drs. Stavely and Fried, of the Squibb Institute for Medical Research in the *Journal of the American Chemical Society*.

Inter-Society Committee for a National Science Foundation:

Report of the Meeting of December 28, 1947

Dael Wolfle, *Secretary-Treasurer*

THE SECOND MEETING OF THE Inter-Society Committee for a National Science Foundation, held in Chicago at 10 A.M. on December 28, 1947, was attended by 42 representatives of the member associations and 33 observers.

The treasurer reported that contributions to the Committee had totaled $2,735.00, that expenses had been $1,851.39, and that the balance was $883.61.

Harlow Shapley reported for the Executive Committee a series of recent conferences with Senator H. Alexander Smith, Representative John H. Wolverton, representatives of the Bureau of the Budget, and Dr. Vannevar Bush. During these conferences a proposed new bill was drafted. Although the basis used was S.526 as it was passed by the Senate and House of Representatives in 1947, that bill was modified in several respects in order to take account of the objections which President Truman had expressed in his veto message.

The Committee discussed at some length the details of the revised bill, the size of the possible appropriation for a National Science Foundation, and the possibility of introducing greater changes into S.526 than those described by Dr. Shapley.

W. P. Anslow (speaking for Homer Smith) presented a statement prepared by a number of persons formerly active in the Committee in Support of the Bush Report. The statement read:

We recommend S.526 with modifications and amendments as follows:

(1) We think a 9-man Board would be better than a 24-man Board.

(2) We propose an amendment which would give the President the power to appoint the Director after receiving nominations from the Board, and which would give him the power to remove the Director.

(3) The provision for the Interdepartmental Committee should be amended to place the direction of its activities directly under the President's authority.

(4) The provisions for special commissions seem unnecessary and should be eliminated.

These recommendations are not presented as something to be urged upon the Committee, but as a point of view which, it is hoped, will be given serious consideration. The above recommendations have been endorsed during the past week by Dr. Roger Adams, Dr. Boris A. Bakhmetcheff, President Isaiah Bowman, Dean Charles E. MacQuigg, Dr. Walter W. Palmer, Dr. Homer W. Smith, and Mr. Bethuel M. Webster.

Discussion of this statement brought out the agreement between its first and second recommendations and the compromise proposed last May by the Inter-Society Committee and transmitted to all congressmen directly involved in preparing the legislation. The third recommendation had already been cared for through the creation by Executive Order of an Interdepartmental Science Committee. As to the fourth, Dr. Shapley suggested to Senator Smith the dropping of the special commissions and discovered that these provisions arose through the particular interest of individual congressmen in legislation for specific medical researches.

W. M. Higinbotham read two resolutions proposed by the Federation of American Scientists. The resolutions were:

RESOLVED that the Federation of American Scientists urges the continuance of a vigorous program by the Inter-Society Committee for a National Science Foundation, to ensure:

(1) Legislation creating an effective agency for national support of scientific research and training.

(2) Effective assistance by scientists to such an organization once established.

RESOLVED that the Federation of American Scientists urges the Inter-Society Committee to work for National Science Foundation legislation embodying the following:

(1) An organization integrated into the Federal Government, with a full-time administrator appointed by the President, and with direct responsibility for disbursal of Federal funds; and assisted by an advisory council from representative fields of science, government, and the public.

(2) Specific assignment to the Foundation of responsibility for formulation of national science policies, with the right and duty to survey public and private research, and to make recommendations for its coordination.

(3) Full discretionary power for the Foundation to set up necessary divisions and commissions without prior legislative enumeration.

(4) Pending the establishment of a general education program, responsibility of the Foundation for developing the Nation's scientific personnel through scholarships and fellowships.

(5) Provision for distribution on a geographic and population basis, to privately and publicly supported institutions alike, of part of the funds allotted for support of research and for training of personnel.

(6) Authority for the Foundation to publish and disseminate to scientists and the public results of scientific

inquiry, and to promote international scientific cooperation.

(7) Free availability or dedication to the public of all patentable discoveries made during research financed through the Foundation.

(8) Provision that all research supported by the Foundation be nonsecret.

(9) Provision for a military liaison committee to ensure that results of research supported by the Foundation are brought promptly to the attention of military agencies.

Discussion by the members of the Inter-Society Committee indicated that the specific provisions of the second resolution were considered more desirable by many scientists than were the provisions of S.526. Agreement between some of the recommendations contained in the resolution and the results of the poll conducted in March 1947 by the Inter-Society Committee was emphasized. However, the prevailing opinion appeared to be that decision on the action which should be taken in attempting to incorporate these recommendations into the proposed legislation should be left to the discretion of the Executive Committee.

Chairman Day reported that it was the unanimous recommendation of the Executive Committee that the Inter-Society Committee lend its support to the adoption of a bill similar to S.526, but changed to take account of the President's objections as stated in his veto message last summer (*Science,* September 12, 1947, p. 237). Except for these changes, he advised leaving the bill as nearly as possible in the form in which Congress had already passed it. He expressed the hope that such a bill would be introduced in identical form in both houses of Congress and that it would be adopted as a bipartisan measure.

A motion was made that the Executive Committee be given authority to act in the name of the Committee as a whole, following the policy outlined by Chairman Day or modifying that policy if modification seemed desirable to the Executive Committee. The motion was seconded and passed unanimously.

The Chairman suggested that the Committee elect new officers. It was moved that the existing membership of the Executive Committee be continued. The motion was seconded and passed unanimously.

It was moved and seconded that the Inter-Society Committee be dissolved upon the enactment of a satisfactory National Science Foundation act. In opposition to this motion, several members pointed out that the Committee might be able to make recommendations concerning the personnel of the Foundation and that it was impossible at this time to know what functions the Committee might be able to perform if a National Science Foundation becomes law. Upon vote, the motion lost.

It was then moved that the Executive Committee convene a meeting of the Committee as a whole as soon as possible after the passage of the bill if a National Science Foundation act is adopted. The motion was seconded and passed.

The meeting adjourned at 12:30 P.M.

Adjournment of the Committee as a whole was followed by a meeting of the Executive Committee. Present were Chairman Day, Vice-chairman Shapley, Secretary-Treasurer Wolfle, and Members-at-large Gerard, Gustavson, and Whitaker. C. G. Suits was absent. The Executive Committee agreed upon the desirability of preparing a list of persons to be proposed to the President for membership on the National Science Foundation if and when one is established. It was agreed that the Committee's recommendations should be ready for submission immediately upon enactment of the proposed legislation. The secretary-treasurer was therefore instructed to send to all members of the Committee a request for nominations and to submit the list of nominees to the members of the Committee for final voting on those to be recommended to the President.

Association Affairs

Section on Botanical Sciences (G)

The interest of botanists in the Chicago meetings is attested by the fact that, of the space in the *General Program* devoted to the programs of the sections and societies, over one-fifth was devoted to the botanical groups. Taking into consideration the division of the larger programs into sections, 18 distinct botanical programs had been arranged. When to these are added the 14 programs of the various societies which include both botanists and zoologists, supported in considerable part by botanists, over a third of the total program was of interest to students of the plant sciences. Under such circumstances, it was inevitable that numerous meetings had to be scheduled concurrently. This has always been the case in recent years, but it seems to have been more conspicuously the case at the Chicago Meeting than at any of the earlier ones.

In accordance with the current trend, many joint meetings and symposia had been arranged. Such sessions serve to offset, at least in some degree, the tendency to extreme specialization by informing specialists as to what is being done in related fields and especially by encouraging the development of borderline investigations. Among such symposia may be mentioned that on "Genetics of Microorganisms," sponsored by the American Society of Naturalists in cooperation with 8 other groups and presenting recent knowledge in this field relating to viruses, bacteriophage, bacteria, and fungi. That on "Mathematical Biology," arranged by the Biometric Section, American Statistical Association, in cooperation with the Biometric Society, occupied four sessions. The traditional program of Section G with affiliated plant societies was arranged as a symposium on growth and correlation. The numerous other symposia were in general more limited in their scope, but with few exceptions afforded opportunity to workers in two or more different fields to learn something of what is going on in others.

At the opposite extreme were some of the more specialized programs. The Botanical Society of America, now operating through 5 sections, had as many as 6 meetings going on at one time, and the meetings of the American Phytopathological Society were somewhat similarly split up into groups concerned with special topics. In the case of a few of the smaller societies, all the meetings were held jointly with other groups.

As usual, the Biologists' Smoker, held in the Chicago Natural History Museum on Monday evening, afforded an excellent opportunity for informal discussion and renewal of acquaintanceship. (G. W. MARTIN, *Secretary.*)

The Chicago Meeting, December 26-31, 1947

From all reports, the Chicago Meeting was one of the most successful in the history of the Association. Secretaries of the 67 cooperating sections and societies, thus far reporting to the Washington office, have been unanimous in their expressions of appreciation not only of the high quality of the different programs but also of the physical facilities placed at their disposal by their Chicago hosts and the general atmosphere of good fellowship.

In the headlong rush of events during the 6-day meeting period, few members pause to reflect upon the organization of the meeting unless something goes wrong, for it is traditional to expect those privileged to serve on local committees to accept their full responsibilities and to carry them out to perfection. It is equally traditional that committee volunteers expect no reward other than the opportunity to facilitate cooperation among scientists. In view of the excellence of the recent meeting, however, special tribute must be paid to the chairmen and members of the local committees organized in Chicago to provide funds and equipment and to assist in handling entertainment, registration, and publicity. Paul Jenkins, executive secretary of the Chicago Technical Societies Council, served as general chairman and coordinated the activities of the various committees. R. T. Van Niman, Motiograph Corporation, directed the procurement of equipment for over 275 sessions. A resident of Chicago, he made his headquarters in the Sherman Hotel, where he was available 24 hours a day throughout the meeting period. Distributing equipment—projectors, microscopes, chemical apparatus, etc.—and scheduling operators were among the most important of his many duties. Hans Hoeppner, director of the Information Bureau, The University of Chicago, directed registration from 8:00 A.M. to 9:00 P.M. daily at the Stevens Hotel. His duties included the organization of the registration facilities and scheduling of paid and volunteer assistants to distribute programs, badges, tickets to special functions, and literature relating to the Chicago area.

Another committee chairman who worked long hours during the meeting was Jeannette Lowrey, of the Department of Public Relations, The University of Chicago. It was her responsibility to provide equipment for the press room, which was used by over 100 newsmen, and to assist the Association's press director, Sidney S. Negus, in the preparation and distribution of copy.

The duties of the Finance and Entertainment Committees were completed, for the most part, before the meeting opened. The chairman of the Finance Committee, W. P. Cortelyou, Roosevelt College, and the treasurer, Gilbert A. Force, Illinois Institute of Technology, directed the acquisition and disbursement of $3,000 to cover expenses incurred by the local committees in carrying out their duties. Margaret Scriven, Chicago Historical Society, and Mr. Jenkins, in addition to arranging the general reception, prepared leaflets welcoming conventioners to Chicago and highlighting the places of interest for the entertainment of visiting scientists.

This brief mention of the work of the committeemen scarcely conveys a full appreciation of the time and energy they and their colleagues spent in directing local activities, all at no expense to the Association or to its affiliated societies. Their generosity is striking indeed when it is considered that only one committee chairman, prior to his election, was a member of the Association or a member of any of the societies that met with the Association in Chicago. By the same token, the willingness of nonmembers to engage in work on behalf of the AAAS is evidence of the high esteem in which it is widely held.

Contributions by local members of the AAAS, however, were not lacking. Over 350 gave checks of $3.00 or more to the treasurer of the local Finance Committee, and many volunteered and participated in the tasks of running the meeting. Theirs is gratifying evidence of public-spirited interest among the 35,000 AAAS members who support a federation of 203 affiliated scientific societies with a combined membership exceeding 500,000.

Although it is not possible to name all of those who worked behind the scenes to make the meeting a success, special acknowledgment is due Clifford C. Gregg, director of the Chicago Natural History Museum, and his staff for making the Museum available to the biologists for their Smoker on Monday evening, December 29. This informal affair, held amid the magnificent exhibits of one of the Nation's leading cultural institutions, will long be remembered by those who attended. In addition to the Museum, 16 educational and cultural institutions in the Chicago area participated in the meeting by designating staff members to serve on the local committees and by allowing their buildings and equipment to be used for sessions and social functions. These include the Chicago Historical Society, the University of Illinois, the John G. Shedd Aquarium, George Williams College, Wheaton College, the Chicago Academy of Sciences, Illinois Institute of Technology, the University of Chicago, Lake Forest College, National College of Education, Elmhurst College, Museum of Science and Industry, Saint Xavier College for Women, De Paul University, Northwestern University, and Roosevelt College.

The total registration for the Chicago Meeting was 4,940, the largest in the history of the Association. On only 6 other occasions has the registration exceeded 3,000: Washington, D. C., 1924 (4,206); Philadelphia, 1926 (3,181); New York, 1928 (3,935); Indianapolis, 1937 (3,094); and Philadelphia, 1940 (3,339).

The registration figure falls far short of indicating the total attendance at the meeting because, as in the case of previous meetings of the Association, registration was not mandatory. This year, to meet the rising costs of operation, the secretaries of the societies were asked to take administrative steps to increase registration. Most societies cooperated wholeheartedly and through executive action voted to require evidence of registration with the Association for admittance to their sessions. However, some societies preferred less vigorous measures. In order to have an equitable policy, especially in the case of joint sessions, the administrative officers of the Association therefore recommended that the chairman of each session merely ask nonregistrants in attendance to register before the next meeting and not attempt to proctor the meetings.

Ordinarily it is difficult to estimate the size of the required registration staff and the number of programs and badges to be purchased in order to meet maximum needs. Experience has shown that if registration estimates are exceeded, lack of supplies and personnel cause much ill will, whereas an excess of both may add materially to the deficit that is annually incurred in the operation of the meeting. The drive to induce greater registration increased the uncertainty of demand. That registration would be larger than usual was indicated by the fact that over 2,000 registered in advance of the meeting. It was anticipated, however, that the net effect of merely recommending registration would not greatly increase the number of registrants, and the final estimate placed the total number of registrants between 5,000 and 5,500. The deficit for the Chicago Meeting was slightly in excess of $1,300. Had registration been required of all those attending the meetings of the

sections and societies, there is little question but that the income from this source would have been sufficient to cover meeting expenses and helped defray the cost to the societies of renting session rooms.

A breakdown of 4,288 registrants gave the following distribution by section: Mathematics, 68; Physics, 296; Chemistry, 678; Astronomy, 16; Geology and Geography, 108; Zoology, 822; Biology, 498; Botany, 903; Anthropology, 22; Psychology, 124; Social Sciences, 39; History and Philosophy of Science, 18; Engineering, 66; Subsection on Medicine, 236; Subsection on Dentistry, 69; Subsection on Pharmacy, 49; Agriculture, 176; Education, 100. Of this number, 2,645 were members of the Association, 370 were students, and 1,273 were nonmembers. It is obvious from these figures that the number of registrants was much less than the number attending the meetings. Attendance at the Biologists' Smoker held in the Museum was officially tabulated at 5,575 persons, exclusive of Museum personnel.

There were registrants from every state in the union and from the territories of Alaska and Hawaii. Transients from 26 other nations registered, including 14 who gave their home residence as China, 28 India, and 73 Canada. States contributing more than 90 registrants were: California, 105; Illinois, 1,416; Indiana, 239; Iowa, 148; Maryland, 93; Massachusetts, 102; Michigan, 181; Minnesota, 131; Missouri, 114; New York, 290; Ohio, 217; Pennsylvania, 138; and Wisconsin, 193. A total of 96 registered from the District of Columbia.

The annual meetings of the Association are among the most widely publicized scientific events of the year. In addition to their appearance in scientific journals, the reports of scientists presented on these occasions find far-flung outlets through public channels—newspapers, periodicals, and the radio. The organization of the National Science Writers' Association and its affiliation with the AAAS, and the establishment of the George Westinghouse-AAAS Science Writing Awards, reflect the interest of scientists and science writers alike in the support of high-caliber reporting that is timely, accurate, informative, and interesting.

The radio coverage of the Chicago Meeting was larger than that of any previous meeting. Over 15 network programs originating in Chicago were broadcast during the convention period, and as many more were heard only over local and regional stations. Through informal interview, forum, and other types of radio programs, scientists themselves had an opportunity to interpret accurately to the public their own fields of specialization. Many took part for the first time in unrehearsed discussions recorded for delayed broadcasts. Those who had been skeptical of this method of reporting scientific progress were won over by appreciative letters from members of the radio audiences.

The *General Program* for the Chicago Meeting listed 2,019 papers; 1,809 were presented orally, 164 by title, and 46 by demonstration. These were distributed among 340 sessions—31 on Friday, 59 on Saturday, 50 on Sunday, 95 on Monday, 81 on Tuesday, and 24 on Wednesday. The maximum number of sessions held simultaneously (Monday afternoon) was 41. Each successive postwar meeting has shown a substantial increase in the number of sessions over the previous one, and if this trend continues, meetings of the Association will soon be limited to two or three of the larger metropolitan areas. The principal alternatives are to: (1) reduce the number of sessions; (2) schedule the meetings of the sections and their related societies at different dates in the same city; (3) have only the sections meet with the Association, the societies organizing and holding their meetings apart from the parent organization; (4) appoint a special AAAS meeting committee each year to determine the nature and scope of the program and to invite the speakers, without the participation of the sections and societies in other than an advisory capacity. A combination of these alternatives may be the best solution to problems of space, time of year, choice of location, etc., which vary with the society or the occupational restrictions affecting its members. The Association's Centenary, to be held in Washington, D. C., in September, is being organized by a special meeting committee, and the outcome of this procedure will provide information of use in establishing future meeting policy. (J. M. HUTZEL, *Assistant Administrative Secretary.*)

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AAAS
Centennial Celebration
Washington, D. C.
September 13–17, 1948

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NEWS and Notes

James C. Peebles, dean of engineering at Illinois Institute of Technology, will retire at the end of August. Dean Peebles expects to prepare a history of Armour and Lewis Institutes (combined in 1940 to form Illinois Tech), with which he was associated for many years.

Cecil J. Watson, professor of medicine, University of Minnesota Medical School, will deliver the 6th Harvey Lecture of the current series at the New York Academy of Medicine on March 18. Dr. Watson will speak on "Urobilin and Stercobilin."

Gordon M. Kline, chief of the Organic Plastics Section, National Bureau of Standards, has recently assumed added duties as assistant chief, Division of Organic and Fibrous Materials.

George Tunell, formerly of the Geophysical Laboratory, Carnegie Institution of Washington, has been appointed associate professor of geology, University of California, Los Angeles.

Warner W. Carlson, formerly with the Department of Research in Pure Chemistry, Mellon Institute, has been made associate professor on the biochemistry staff of the Medical College of Alabama, Birmingham.

P. K. Stumpf, formerly associated with the Virus Laboratory, University of Michigan, and the Enzyme Laboratory, Columbia University, has been appointed assistant professor of plant nutrition in the College of Agriculture, University of California, Berkeley.

James F. Nance, formerly research project associate in the Department of Botany, University of Wisconsin, was appointed assistant professor of botany at the University of Illinois, beginning with the second semester of the current academic year. Taking the place of David L. Taylor, who died early in December, Dr. Nance will offer courses and develop the fields of plant metabolism and plant nutrition.

Earl A. Evans, Jr., head of the Mission on Science and Technology (London), recently represented U. S. science at the opening of the Pontifical Academy of Science in Vatican City.

V. G. Grove, professor of mathematics, Michigan State College, is visiting professor at the University of Puerto Rico during the present term.

J. E. Hobson, director of the Armour Research Foundation of Illinois Institute of Technology since 1944, became director of the Stanford Research Institute on March 1.

Albert L. Henne, professor of chemistry at Ohio State University, will be guest lecturer during the first term of summer school at the University of Colorado. Dr. Henne, an authority on the chemistry of fluorine compounds, will present a lecture course for graduate students in chemistry.

E. B. Stephenson, G. R. Irwin, Elias Klein, and **W. H. Sanders** have been appointed superintendent, associate superintendent, and consultants, respectively, in the newly established Mechanics Division at the Naval Research Laboratory, Washington, D. C.

John A. Luetscher, Jr., member of the Johns Hopkins Medical School faculty since 1940, will become associate professor of medicine at Stanford University in the fall.

Grants and Awards

Massachusetts Institute of Technology has just received from The Texas Company a grant of $250,000 which, according to the announcement, will be used "for long-range pure research in nuclear fission and related basic studies on the ultimate nature of matter and energy, to construct high-voltage equipment of advanced design, and to train scientists in nuclear theory and its application." Major part of the work will be carried on in the Laboratory for Nuclear Science and Engineering. Aside from the Institute's cyclotron and two electrostatic generators with capacities to 4,000,000 volts which are already in operation, the 300,000,000-electron-volt synchrotron, now being constructed, and a 12,000,000-volt electrostatic generator will be utilized.

The Permanente Foundation, Oakland, California, Department of Medical Research, has received a grant of $10,000 for expansion of its experimental and clinical studies on peptic ulcers and on the effectiveness of Bentrogastron. These studies will be under the direction of Franz R. Goetz, director of the Department.

The Cinchona Products Institute, New York City, has recently made available funds for research at the School of Medicine, Emory University, Atlanta, Georgia. The funds will be used for studies on the use of the combination of cinchona alkaloids and other drugs as curative agents in experimental avian malaria by Arthur P. Richardson and Harry A. Walker, and on the effect on influenza virus of cinchona alkaloids to be carried out by William F. Friedewald.

American citizens who contributed to the Allied war effort in various fields of scientific research and development were honored last month by the British Government. The British Ambassador, Lord Inverchapel, announced the awards. Vannevar Bush, wartime director of OSRD, was made a Knight Commander of the Civilian Division of the Most Excellent Order of the British Empire. Two college presidents, Karl T. Compton (MIT) and James B. Conant (Harvard), and Richard C. Tolman, of California Institute of Technology, former vice-chairman of NDRC, were designated Honorary Commanders of this Division. The King's Medal for Service in the Cause of Freedom went to Bennett Archambault, scientific attaché to the U. S. Ambassador; J. C. Boyce, Department of Physics, New York University; H. M. Chadwell, Rockefeller Foundation; Hans T. Clarke, Department of Biochemistry, Columbia University; C. P. Haskins, director of the Haskins Laboratories, New York City; Alfred L. Loomis,

Tuxedo Park, New York; W. A. Noyes, Department of Chemistry, University of Rochester; I. I. Rabi, Department of Physics, Columbia University; Mina S. Rees, chief of the Mathematics Division, Office of Naval Research; C. G. Suits, vice-president and director of research, General Electric Company; Warren Weaver, Rockefeller Foundation; F. C. Bishopp, assistant chief, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture; and Clark B. Millikan, professor of aeronautics and director of the Cooperative Wind Tunnel, California Institute of Technology.

The Superior Service Award of the U. S. Department of Agriculture has been presented to the Curly Top Project of the Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, for breeding and introducing sugar beet varieties resistant to curly top for use in the intermountain West. J. J. Overby, Assistant to the Secretary of Agriculture, made the presentation at a banquet of the American Society of Sugar Beet Technologists in San Francisco, California, on January 14. Eubanks Carsner accepted the award on behalf of the 16 members of the project engaged in the research.

Robert H. Lowie, chairman, Department of Anthropology, University of California, Berkeley, has won the Viking Fund medal and prize for his contributions to the field of cultural anthropology. The medal and prize are awarded annually "for excellence of research in each of the fields of archaeological, physical, and cultural anthropology."

Fellowships

The U. S. Atomic Energy Commission has announced a $1,500,000 research fellowship program in the physical sciences basic to atomic research and development. The new program, covering such fields as physics, chemistry, metallurgy, mathematics, geology, and astrophysics, will implement the recently announced program for training qualified persons in the biological sciences and medicine (*Science*, February 6, p. 136). Both programs will be administered by the National Research Council.

Two groups of research fellowships are proposed, one at the postdoctoral level and one at the predoctoral level. During the first year not more than 30 fellows will be selected for the postdoctoral group, for one or two years of study. The predoctoral group wil consist of no more than 150 fellowships, awarded to candidates who have completed one or two years of graduate work and who have been accepted as candidates for the doctor's degree.

Six Graduate Research Fellowships in psychology and education and related fields are being offered by Pennsylvania State College, the stipends ranging from $1,000 to $2,400. Fellows will work in instructional sound motion-picture research under an Instructional Film Research project being directed by C. R. Carpenter. Qualifications include readiness to undertake and complete in one year research for the Ph.D. or Ed.D. thesis, one or two years of advanced graduate training, or the holding of either degree. Further information may be obtained from Dr. Carpenter.

Colleges and Universities

Tufts College has announced the establishment of an Institute for Applied Experimental Psychology. The new Institute, to be housed in North Hall, the new quarters of the Department of Psychology, will be operated in close relationship with the Department of Psychology and the Tufts Research Laboratory of Sensory Psychology and Physiology, which is this year celebrating the 10th anniversary of its establishment. The Institute's staff will work in relationship with the Engineering School, the Medical School, and other science departments.

The work of the Institute will center in (1) applied visual research, including the study of reading and basic research on the retina, (2) bioelectric phenomena of the muscle and nervous systems, (3) synthetic training devices for industry and the armed forces, (4) analysis of human motor skills, (5) preparation of training manuals for those who are to use equipment, as well as development of handbooks of psychophysiological functions, (6) statistical methods, with special reference to the design of investigations in applied experimental psychology.

Four internships in applied experimental psychology for qualified students who already hold the Ph.D. degree or its equivalent are available for the academic year 1948–49. Interns who meet special qualifications may be awarded the degree of Doctor of Science upon completing an assigned research thesis and passing appropriate examinations. These examinations will be conducted by the Institute staff and by visiting examiners from other universities.

Every effort will be made to assist interns to secure satisfactory living accommodations near the Institute.

Members of the staff include J. L. Kennedy, L. Carmichael, D. J. Crook, M. N. Crook, W. F. Dearborn, R. M. Gottsdanker, A. C. Hoffman, E. R. Keislar, R. C. Travis, N. Y. Wessell, and cooperating scientists in the fields of physics, mathematics, electrical engineering, physiology, and applied physical anthropology.

Further information may be obtained from John L. Kennedy, Director, Institute of Applied Experimental Psychology, Tufts College, Medford 55, Massachusetts.

The Poultry Division, Washington Agricultural Experiment Station, Pullman, has moved to new quarters which will provide expanded facilities for fundamental investigations in the fields of poultry nutrition and physiology of reproduction. Wilson Henderson (D.V.M., 1947, University of Toronto) and W. Donald Graham (Ph.D., 1945, University of Toronto) have recently been added to the staff.

A reference library of mineral photographs, expected to be the most complete in the world, is being assembled at Harvard's Berman Memorial Laboratory. According to the directors, Clifford Frondel and C. S. Hurlbut, Jr., the library "will make possible quicker and more accurate identification of minerals and minimize the need for many time-consuming and difficult chemical tests now required." At present about 1,500

mineral photographs are on file. Another phase of the project involves examination of the 15,000-odd synonymous names for minerals. A method known as "powder diffraction" is utilized in the mineral identification work. With this method a finely powdered sample of the mineral to be identified is exposed to an X-ray beam, the diffracted beams being "caught" on a photographic film. The developed picture shows a series of concentric dark rings which are not the same for any two materials. One camera in the Laboratory enables photographing of minerals heated to temperatures as high as 900° C.

At the 69th commencement of Case Institute of Technology on January 24, the honorary degree of Doctor of Humane Letters was conferred upon William E. Stevenson, president of Oberlin College, and the degree of Doctor of Science was awarded to Merle A. Tuve, director, Department of Terrestrial Magnetism, Carnegie Institution of Washington. President Stevenson gave the commencement address on "The Firing Line of Life."

The annual John Wyckoff Lectures at New York University College of Medicine were delivered February 16–17 by Bernardo A. Houssay, director of the Institute of Biological Research, Buenos Aires, and 1947 Nobel Prize winner in Medicine. Dr. Houssay spoke on "Carbohydrate Metabolism and Diabetes." This was the 10th series to be given under the John Wyckoff Lectureship, established by Phi Delta Epsilon.

Massachusetts Institute of Technology has announced a series of lectures on statistical methods, to be given by L. H. C. Tippett, chief statistician of the British Cotton Industry Research Association. From May 3 through May 7 Dr. Tippett will present five lectures on "Statistical Methods for Industrial Quality Control," emphasis being laid on the rationale of quality control and a knowledge of elementary algebra, simple averages, and elementary notions of probability being assumed. The five lectures to be given from May 10 through May 14 will cover "Statistical Methods for Technical Investigation and Experimentation," and knowledge of the subject matter of the first series and of algebra will be assumed. All lectures will be held in Room 6–120, from 4: 00 to 5: 00 P.M. The fee per person is $15.

On May 14 at 6: 00 P.M. there will be a dinner meeting, open to those interested in statistical methods in quality control and experimentation, in the Campus Room of Graduate House. At that time Walter A. Shewart, of the Bell Telephone Laboratories, will speak on "The Future of Statistics in Industrial Research and Quality Control." Edward R. Schwarz, who is in charge of the Division of Textile Technology at MIT, will be chairman of the meeting. The fee for this meeting, which will be limited to 200 persons, will be $3.00.

Payment of fees should be made by April 23, checks being made payable to D. L. Rhind, Bursar. All correspondence and checks should be addressed to H. A. Freeman, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

A bulletin from the College of Natural Sciences, Yenching University, Peiping, China, gives a great deal of interesting information not only about the actual working setup of the College but about assistance received from groups and organizations outside of China. Total enrollment in the College as of last October was 295, 129 being freshmen. Upperclassmen are divided according to the subject of their interest as follows: biology, 17; chemistry, 25; home economics, 17; mathematics, 4; physics, 12; industrial training, 42; premedicine, 45; and prenursing, 4. Yenching alumni in Hawaii have raised a fund which is being used to purchase books in physics, chemistry, and biology, to re-equip the Laboratory of Physical Chemistry, and to finance several undergraduate scholarships. An Industrial Training Program has been made possible with funds donated by industrialists in Tientsin and Shanghai. The much-needed money will enable the University to offer additional courses in applied science, to enlarge the teaching staff, and to equip the required laboratories. During the last two years of the five-year course the students will spend half time in factories under the supervision of Yenching faculty. The Home Economics Department will also be expanded by virtue of a special fund of $10,000 raised through the efforts of Ava B. Milam, dean of Home Economics at Oregon State College. We also learn that the Ella Sachs Plotz Foundation has donated $450 for nutrition research, and that friends of the University in Britain and elsewhere have given generously toward the rehabilitation program. The University is in this period concentrating on undergraduate laboratory courses. A very limited number of graduate students are being accepted, and research programs are greatly curtailed.

In spite of the generosity of outside groups and individuals to certain institutions, the general educational situation in China is critical. A letter recently received from Ju Chin Chu, assistant professor of chemical engineering at Washington University, St. Louis, indicates that although most of the educational and research facilities in China were stripped by Japan and only a very small percentage of the national budget is allotted to education, morale in institutions of higher learning is still high. His letter stresses the importance of preserving this morale through material help. Gifts of books and both current and back numbers of journals would be most welcome.

The State Teachers College, Duluth, Minnesota, on July 1, 1947 became the University of Minnesota, Duluth Branch. This new branch of the University is offering curricula in major and minor fields in each department and preprofessional curricula in the fields of medicine, veterinary medicine, pharmacy, dentistry, medical technology, nursing, agriculture, forestry, and engineering. The Division of Science and Mathematics, headed by John C. Cothran, is divided into four departments: Biology, with Olga Lakela, professor of botany, as head, assisted by Mark F. Keith and John B. Gerberich, assistant professors in zoology, and Theron O. Odlaug, associate professor in zoology; Chemistry, with Dr. Co-

ran, who is professor of chemistry, as head, and Margaret A. Brodahl, Myrle C. Wagner, and Louis W. Blacziak as instructors; Physics, with William A. Porter, assistant professor, as head, and Howard Hanson as assistant professor; and Mathematics, with William E. McEwen, associate professor, as head, and Mary I. Elwell and Clarence B. Lindquist as assistant and associate professors, respectively.

The University of Texas Medical Branch, under terms of the will of the late Mrs. Rosa H. Ziegler, of Galveston, will receive $300,000 for a unit to be named the Henry and Rosa H. Ziegler Tuberculosis Hospital, which will afford facilities for teaching and research in acute and chronic tubercular conditions.

Meetings and Elections

The Federation of American Societies for Experimental Biology will meet in Atlantic City, New Jersey, from Monday, March 15, through Friday, March 19. The Federation is composed of the American Physiological Society, American Society of Biological Chemists, American Society for Pharmacology and Experimental Therapeutics, American Society for Experimental Pathology, American Institute of Nutrition, and American Association of Immunologists. The scientific sessions, 96 in number, will be held in the Atlantic City Convention Hall. The headquarters hotel will be Chalfonte-Haddon Hall.

The Southeastern Section of the Botanical Society of America, Inc., will hold its annual spring meeting jointly with the Association of Southeastern Biologists at the University of Florida, Gainesville, April 16–17. A program including addresses, symposia, and field trips has been arranged. Members of the Society and friends who wish to attend this meeting should communicate at once with John H. Davis, chairman of the Local Committee, University of Florida.

Annual meetings of three American societies are being held concurrently in Denver, Colorado, April 26–29. The Shirley-Savoy Hotel will be headquarters for the American Association of Petroleum Geologists, while the Cosmopolitan Hotel will serve the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists. The Rocky Mountain Association of Geologists is the host organization. The technical program will be devoted mainly to papers pertaining to the Rocky Mountain area. One preconvention and two postconvention field trips have been planned. That on April 26 will be to the foothills along the Front Range from Boulder to Golden. From April 30 to May 1 there will be a trip from Denver through Colorado Springs to Canyon City and the Royal Gorge and return. Those going on the second trip will leave Denver April 30 and return May 2. Their itinerary will include Denver Basin, Front and Mosquito Ranges, pre-Cambrian to Cretaceous formations along the Eagle and Colorado Rivers, an oil-shale demonstration plant of the U. S. Bureau of Mines, and Tennessee and Kenosha Passes.

The Ohio Academy of Science is to hold its annual meeting on May 6–8 at the University of Toledo. J. J. Wolford, chairman of the Geology Section, has announced that his section is planning a field trip through northwestern Ohio on May 8 and possibly for part of May 9, under the leadership of J. E. Carman, who has specialized in that particular region. This will take the place of the spring trip which is ordinarily held over Decoration Day weekend.

The American Psychiatric Association's 1948 meeting will be held in Washington, D. C., May 17–20, inclusive, with the Statler serving as headquarters hotel. Hotel accommodations should be made through the offices of the Association, Room 924, 9 Rockefeller Plaza, New York 20.

The Medical Library Association, which this year celebrates the 50th anniversary of its founding, will hold its annual meeting in Philadelphia, May 28–30, with headquarters at the Hotel Warwick. The commemoration of the Association's founding in Philadelphia in 1898 has a prominent place on the program with addresses on "The History of the Association," by Archibald Malloch, New York Academy of Medicine; "The Medical Library Association and Medicine," by Chauncey D. Leake, University of Texas; and "The Medical Library Association Faces the Future," by the president, Mrs. Eileen R. Cunningham, Vanderbilt University School of Medicine Library. The speaker at the annual dinner on May 29 will be O. H. Perry Pepper, of the University of Pennsylvania. Group meetings will be held to discuss practical library problems, and these, with the business sessions and social functions, should make the three-day convention attractive to all who are interested in the work and development of medical libraries.

The Association for Research in Ophthalmology will hold its annual meeting on June 21–22 in Thorne Hall, on the Northwestern University Medical School campus in Chicago. Further details will be announced upon completion of the program.

The South African Association for the Advancement of Science is to hold its next annual meeting in Lourenço Marques from June 28 to July 2.

At the invitation of the American Society for X-Ray and Electron Diffraction and of the Crystallographic Society of America the first General Assembly and International Congress of the International Union of Crystallography will be held at Harvard University, Cambridge, Massachusetts, from July 28 to August 3. Those planning to attend this meeting should inform Clifford Frondel, Mineralogical Laboratory, Harvard University, if they have not already done so through ASXRED or the CSA. Further information will be announced in *Science*, *Acta Crystallographica*, *Nature*, and *The Journal of Scientific Instruments*.

Organization of a Society for the Social Study of Invention (*Science*, December 19, 1947, p. 613) was achieved at the AAAS Meeting in Chicago. According to the organizational procedures, which were proposed by S. C. Gilfillan, research associate in sociology at the University of

Chicago, and adopted with certain amendments, the aims of the Society are "to study, promote, rationalize, and economize invention and its utilization, and incidentally to build the structure of culture generally." Fields to be covered by the new Society include: (1) the social causes of invention, (2) the social effects of invention, (3) prediction of inventions and effects, (4) description and measurement of invention in its present settings, (5) the history of invention and inventors as a craft, not individually, and (6) the psychology of invention. The Society will promote scientific study of these matters, divulging its findings, especially to governmental authorities. When feasible, one or more serial publications will be issued. Dues are now set at $2.00 a year, and any person, scientific, academic, or government body, or commercial corporation, except a library, may become a member. All powers under the Constitution are to be exercised by the directors and by committees and officers designated by them. The directors are: Wm. F. Ogburn, Department of Sociology, University of Chicago; Waldemar Kaempffert, science editor, *New York Times*; Joseph Rossman, patent lawyer, Washington, D. C.; Watson Davis, director of Science Service; J. W. Oliver, Department of History, University of Pittsburgh; Robert K. Merton, Department of Sociology, Columbia University; J. B. Gittler, Department of Sociology, Iowa State College; C. W. Ooms, recent Commissioner of Patents; and S. C. Gilfillan, who is also serving as secretary.

The Institute of Mathematical Statistics has announced the election of Abraham Wald, head of the Department of Mathematical Statistics, Columbia University, as president; Churchill Eisenhart, chief of the Statistical Engineering Laboratory, National Bureau of Standards, as a vice-president; and Henry Scheffé, of the University of California at Los Angeles, as a vice-president.

The American Anthropological Association has elected Harry L. Shapiro and Loren C. Eiseley president and vice-president, respectively, for 1948. D. B. Stout, of Syracuse University, is secretary of the Association.

Fourth Cryogenic Conference

The Fourth Cryogenic Conference sponsored by the Office of Naval Research was held at The Ohio State University on October 27–28, 1947.

The program of 19 invited papers on various phases of Low-Temperature Research was divided into three half-day sessions, and a fourth half-day was devoted to an inspection trip through the exceptionally well-equipped Cryogenic Laboratory of The Ohio State University and to an informal social session given by the Laboratory.

The first session was presided over by Urner Liddell, chief of the Physics Branch, Office of Naval Research, and was devoted to a group of papers reporting research on the Superfluid Properties of Liquid Helium II. The first two papers, by Lars Onsager, of Yale University, and by F. London, of Duke University, were theoretical treatments of quantum conditions for excitation of superfluid atoms into normal atoms and of heat flow in liquid helium. The third paper, by Lothar Meyer, of The University of Chicago, was likewise a theoretical paper which sought to account for the velocity of Second Sound and for the abnormal thermal conductivity of He II in terms of a time of relaxation of the interactions between super atoms and normal atoms. The fourth paper, by C. T. Lane, presented experimental results, obtained at Yale, on the distribution of the isotope He^3 between liquid and vapor phases. A second paper by Lane discussed methods of producing "Second Sound" in Helium II. The final paper of the morning session, by J. G. Daunt, presented the results of recent experiments at Ohio State on separation of the He^3 isotope by film flow and by flow through narrow channels.

The Monday afternoon session of the conference, presided over by L. M. McKenzie, of the Office of Naval Research, was devoted to papers on the general topic of Electrical Conductivity and Physics of the Solid State, with special reference to Superconductivity. The first paper of this session was given by D. H. Andrews, of Johns Hopkins University, who described recent observations at that University on the influence of current strength on the semi-superconducting characteristics of columbium nitride, and on the action of columbium nitride as a detector for both radio frequency and infrared signals. The second paper, by R. A. Ogg, Jr., of Leland Stanford University, reported the effect of magnetic fields in lowering the upper consolute temperatures at which liquid-liquid phase separations occur in liquid ammonia-alkali metal solutions.

I. Estermann and A. Foner, of Carnegie Institute of Technology, reported the results of recent measurements on the electrical resistivity of germanium samples at low temperatures, including Hall effect studies. The fourth paper, by F. G. Dunnington and J. R. Feldmeier, of Rutgers University, presented a theoretical treatment of the radio frequency conductivity of normal conductors, as a function of temperature, and outlined an experimental program to test this treatment by measurements at low temperatures. A report of resistivity measurements of semi-conductors, at low temperatures, was given by Vivian Johnson, of Purdue University.

J. J. Fritz, of the University of California, described results obtained in Berkeley on measurements of the heat capacity and magnetic susceptibility of $FeSO_4 \cdot 7H_2O$ as a function of magnetic field strength up to 8,000 gauss, between 1° and 20° K. The final paper of this session was given by W. J. Taylor, of Ohio State, who outlined the program of low-temperature absorption and Raman spectra investigation soon to be initiated at Ohio State, and presented a theoretical treatment of lattice vibrations and their interaction with radiation.

The third session, presided over by H. L. Johnston, director of the Cryogenic Laboratory at Ohio State, dealt with Cryogenic Equipment and Methods. A joint paper by E. C. Kerr and J. T. Clarke described low-temperature calorimetric methods in use at Ohio State. In the second paper of this session S. C. Collins, of Massachusetts Institute of Technology, outlined plans for a helium cryostat that

is designed to produce continuous refrigeration at a temperature level of a few one-hundredths of one degree Absolute. F. C. Squire described the equipment in the newly constructed Cryogenic Laboratory of Rice Institute, and W. T. Ziegler, the hydrogen and helium liquefiers under construction at Georgia Institute of Technology. J. G. Aston gave a report of a tour through European Low-Temperature Laboratories (particularly Leiden), illustrating the talk with lantern slides. A paper by R. A. Ogg presented quantitative results of absorption spectra studies in dilute metal-ammonia solutions, which supported a previous interpretation of two overlapping absorption bands associated with trapped single electron and trapped electron pairs, respectively.

The Tuesday afternoon tour of the Ohio State Cryogenic Laboratory included inspection of the facilities for producing and maintaining low temperatures and of the laboratories in which experimental work is under way. The former include facilities for producing liquid air, liquid hydrogen, and liquid helium, and for separating the components of liquid air, that rank among the best in any laboratory in the world. They also include a 1,200-kilowatt motor-generator set for use on an adiabatic demagnetization cycle to produce temperatures close to the absolute zero. The latter include exceptionally well-equipped laboratories engaged in research in the properties of superfluid helium, superconductivity, low-temperature calorimetry, gaseous and liquid data of state, Joule-Thomson effects, measurement of physical properties (thermal conductivity, viscosity, velocity of sound, and thermal expansion coefficients), measurements of reaction velocity, and absorption and Raman spectra. Also included in the Cryogenic Laboratory are a well-equipped high-temperature laboratory, a mass spectrometer laboratory, a scientific computing laboratory, a materials testing laboratory, a rocket motor laboratory, and a well-equipped shop.

All the papers given in the technical sessions of the Conference dealt with investigations supported by the Office of Naval Research. Representatives of the Naval Research and Naval Ordnance Laboratories, the U. S. Bureau of Standards, the Bell Telephone Laboratory, the General Electric Research Laboratory, and the Westinghouse Research Laboratory also participated in the discussions, by invitation. (H. L. JOHNSTON.)

Deaths

Clara Amity Bliss, emeritus professor of chemistry at Wells College, Aurora, New York, died February 1 at her home in Newburyport, Massachusetts. She was associated with the College from 1893 to 1929, the year of her retirement.

Alexander Maxwell, 69, former director of engineering of the Edison Electric Institute, died February 10 in South Norwalk, Connecticut, after a long illness.

Herbert P. Whitlock, 79, curator emeritus of minerals and gems, American Museum of Natural History, died February 22.

Lloyd Raymond Watson, 71, emeritus professor of chemistry, Alfred University, died on February 26 at his home in Alfred, New York. Dr. Watson was known for his discovery of a method for artificial insemination of the queen bee.

Establishment of a new national scientific organization, with headquarters at Yale University, has just been announced. Sponsored by, and affiliated with, the Society of the Sigma Xi, which also has its headquarters at Yale, the new Scientific Research Society of America is a nonprofit corporation having as its primary purpose the organization of chapters in important industrial laboratories. George A. Baitsell, Sigma Xi's national executive secretary, in making the announcement, said: "It is believed that the combination of the Scientific Research Society of America in industry with Sigma Xi in educational institutions will provide encouragement and assistance to research scientists all over the United States." Cutting across all sciences, "the SRSA will be able, by its local group activities, national lectureships, publications, and grants-in-aid, to develop an exchange of ideas about the latest trends in scientific research and offer other aid not now available to research workers," Dr. Baitsell stated.

A. Oosthoek's Uitgevers Maatschappij, Ltd., Utrecht, Holland, has announced that it will publish a new international review journal, *Acta Hydrobiologica et Protistologica.* In addition to papers on original research work in the fields named, the quarterly journal will contain an up-to-date book list, book reviews, news items, letters to the editor, and miscellaneous items of interest. The Board of Editors includes: Gunnar Alm, Drottningholm, Sweden; H. d'Ancona, Padova University, Italy; Kaj Berg, Copenhague University, Denmark; F. E. Fritsch, London University, England; K. Münster Ström, Oslo University, Norway; W. R. Taylor, University of Michigan (U. S. A.); Mrs. N. Wibaut-Isebree Moens, Amsterdam, Holland; and P. van Oye, Ghent University, Belgium, who is managing secretary.

Make Plans for—

Symposium on Modern Instrumental Methods of Analysis, March 22–24, University of Minnesota.

Pennsylvania Academy of Science, March 26–27, Grove City College, Grove City, Pennsylvania.

American Association of Physical Anthropologists, April 2–4, U. S. National Museum, Washington, D. C.

American Geophysical Union, 29th annual meeting, April 21–23, Washington, D. C.

American Physical Society, 285th meeting, April 29–May 1, Washington, D. C.

TECHNICAL PAPERS

Toxicity of γ-Benzene Hexachloride in Clothing[1]

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Toxicology and Entomology Sections, Medical Division, Army Chemical Center, Maryland

The marked effectiveness of the γ isomer of hexachlorocyclohexane (GBH) as an insecticide and miticide has stimulated the manufacture and experimental field use of this compound, popularized under a trade name, Gammexane. Several months ago it was shown in tests conducted by the U. S. Department of Agriculture at Orlando, Florida, that herringbone twill impregnated with the standard test concentration of 2.0 gm of GBH/square foot of cloth is highly effective against mites and withstands repeated launderings better than other proposed miticide impregnates (*1*).

TABLE 1

LETHALITY OF ACETONE SOLUTIONS OF HEXACHLOROCYCLOHEXANE APPLIED TO CLIPPED OR DEPILATED SKIN*

Species	Mortality fraction at dose					Time of death	No. of survivors showing toxic symptoms
	200	250	400	500	1,000		
	GBH (mg/kg)					(hrs)	
Rabbit	0/1	..	2/2	..	2/2	16–48	None
Guinea pig	..	0/4	..	0/4	1/4	72	None
Rat	..	0/4	..	0/4	1/4	24	1 at 500 mg/kg & 1 at 1,000
Goat	..	..	..	0/1	0/2	..	None

* Within this small series of animals, GBH, either pure or in the 83% mixture, appeared to be equally toxic on both depilated and clipped skin.

However, the appearance of unusual symptoms in two workers engaged in preparing batches of the compound for field tests (*4*) suggested that these symptoms might be manifestations of GBH absorbed through the skin. Since the wearing of impregnated clothing would subject large and varied areas of the body to contact with the impregnate, since during bodily motion the impregnate would be rubbed against the skin, and since, furthermore, impregnated clothing might be worn frequently within a short period of time or continuously for several days (as by troops in the field), it was felt that an investigation of the toxicity of GBH-impregnated cloth was urgent. A small series of observations was, therefore, made on clipped laboratory animals wearing simulated garments impregnated with the agent.

Acetone solutions applied directly to the skin. The toxicity of 40% acetone solutions (a) of the pure γ isomer or (b) of a mixture of hexachlorocyclohexanes containing 83% γ isomer was determined by direct application to the backs and sides of animals clipped or depilated 24 hrs previously. To eliminate ingestion or inhalation of the compound during the initial 72-hr period of observation, the animals were restrained in a ventilated hood or, in the case of goats, placed in stocks outdoors. Results are shown in Table 1.

Impregnated clothing worn as a suit. Bleached herringbone twill cloths were impregnated by spraying with, or by machine-dipping in, an acetone solution of hexachlorocyclohexanes (83% γ isomer) of such strength (approximately 10%) as to yield a concentration of 2 gm of γ isomer/square foot of cloth. After the twill had been air-dried for 24 hrs or longer, suitable holes were cut for the fore and hind legs of the species to be used. The cloths were retained as snugly fitting coats about the trunks of the animals by stapling or taping the overlapping edges of the cloth over the back. The animals had been clipped by electric clippers approximately 24 hrs previously. The covered area per unit body weight

TABLE 2

LETHALITY OF CLOTHING IMPREGNATED WITH GBH
(Fresh impregnation = 2.4 gm of 83% GBH mixture/square foot)

Species	Impregnation	Mortality fraction			
		24 hrs	48 hrs	72 hrs	1 wk
Rabbit	None	0/6	0/6	0/6	0/6
	Fresh	8/10	8/10	9/10	10/10
	Fresh	4/4	4/4	4/4	4/4
	Fresh*	1/4	1/4	3/4	3/4†
	Worn‡	1/6	3/6	4/6	6/6
	3 Launderings*	0/4	2/4	4/4	4/4
	Fresh§	0/3	0/3	0/3	3/3
Guinea pig	None	0/5	0/5	0/5	0/5
	Fresh	0/5	0/5	0/5	0/5
Rat	None	0/3	0/3	0/3	0/3
	Fresh	0/4	1/4	1/4	1/4

* Impregnated by machine dipping.

† The rabbit surviving at one week died at 10 days.

‡ Worn previously approximately 24 hrs by rabbits which died in above groups.

§ These rabbits were restricted for the first 4 days to very small cages so that a minimum amount of movement was possible.

[1] The authors wish to acknowledge the aid of Jane U. Harrison and Lottie K. Jandorf in the animal experiments. Analysis of the impregnated cloth was made by Samuel Sass, Technical Command, Army Chemical Center (*3*).

[2] At present associated with the Research Grants Division, National Institute of Health, Bethesda, Maryland.

corresponded approximately to that for a man in a suit (0.28 square foot/kg) so that about 560 mg of γ isomer were in the cloth/kg of body weight. Table 2 indicates the results.

The symptoms of animals affected, whether by direct skin application or by wearing of impregnated suits, were those typical after parenterally administered GBH: weakness, sometimes flaccid paralysis, and finally periodic convulsions, generally leading to eventual death. The observation period was one week or longer.

In both types of experiments it was evident that, of the species tested, rabbits are most sensitive and guinea pigs least sensitive to cutaneously applied GBH.

Chemical determinations (*3*) of the total loss of hexachlorocyclohexanes from the impregnated suits of rabbits showed the following averages: 17% after one wearing, 23% after two wearings, and 36% after three launderings and no wearings.

While it seemed unlikely that any of the affected animals could have absorbed GBH from a route other than the percutaneous, particularly since at no time was it observed that the clothed animals or the unclothed restrained animals were able to ingest the substance by licking, it was, nevertheless, desirable to rule out inhalation as a possible route of intoxication. Therefore, two rabbits were left for a week in cages with minimal openings and with walls covered by GBH-treated cloth behind a screen, the surface area of the cloth being large enough to produce at room temperature as much vapor as would be given off by an impregnated rabbit suit at body temperature. During an observation period of 10 days, no ill effects were noted. A third rabbit, clothed in a GBH-treated suit, confined in a rabbit box permitting body movement, and placed in a ventilated hood so that vapor could not be inhaled, died within 24 hrs.

Further evidence for the unimportance, in these studies, of inhalation as a toxic route is given by the following experiment: Inasmuch as it was suspected that movement might be significant in bringing about greater absorption through the skin, three rabbits in GBH-treated suits (see Table 2) were confined, in a ventilated hood, in small wire cages permitting the minimal amount of movement consistent with normal respiratory function. After confinement for 96 hrs, only one rabbit had exhibited typical symptoms followed by death, which occurred shortly before it was removed from the cage. The other two, however, began to develop symptoms soon after removal from their cages and eventually died. Since bodily motion seemed to contribute to an increased rate of absorption of GBH in the clothed animals, it is presumed that movement brings about flaking of the small crystals from the fibers and, through chafing by the clothing, causes them to be worked into the skin.

The work of others on the toxicity of GBH to rabbits shows that only small amounts would have to be absorbed to produce symptoms: the acute i.v. LD_{50} is about 4 mg/kg (*5*), while during a 3-week period of daily inunction of the γ isomer in dimethyl phthalate, symptoms occurred with daily doses of 20 mg/kg (*2*). In wearing tests on rabbits with cloth freshly impregnated with acetone at 2.0, 4.0, and 8.0 gm of GBH/square foot, typical symptoms, including convulsions, occurred (*2*).

In conclusion, it may be stated that the effective insecticidal component of hexachlorocyclohexane, the γ isomer, appears to be sufficiently hazardous to some mammals to warrant the utmost caution in its use as a miticidal impregnate at 2 gm/square foot in human clothing. Even at 64% of this concentration, suits were lethal to 4/4 rabbits in 72 hrs. Unless it can be shown that man is markedly more resistant than the rabbit, it is probable that γ-benzene hexachloride can be used safely as an impregnate only at concentrations so low as to eliminate any advantages it might otherwise offer in insecticidal effectiveness and durability over other compounds currently under test.

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Inactivation of 2,4-D on Sweet-Potato Slips With Activated Carbon[1]

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A recent article by Lucas and Hamner (*1*) on the inactivation of 2,4-D in cleaning knapsack sprayers with activated carbon suggested the possible use of this material to protect sensitive field crops from 2,4-D injury.

In order to test the above use, two field experiments were conducted with Unit 1 Porto Rico sweet-potato slips, one on Leeper clay at State College, Mississippi, and one on Sarpy sandy loam at Stoneville, Mississippi.

The soil, which received normal seedbed preparation, was treated with the sodium salt of 2,4-D immediately before planting. The concentrations used were 1,000 and 4,000 ppm (free acid equivalent) at State College, and 1,000, 2,000, 3,000, and 4,000 ppm at Stoneville. The solutions were applied with 3-gal compressed air sprayers at the rate of 155 gal/acre.

One-half of each plot was planted with untreated sweet-potato sprouts and the other half with sprouts, the roots of which were first moistened and then dusted with activated carbon (Norit A, about 1 lb/1,000 sprouts). The treatments were replicated four times at State College and three times at Stoneville.

The results of these tests are shown in Tables 1 and 2. The data show that activated carbon used in this manner minimized the injury to the sprouts from 2,4-D. The treated sweet-potato plants growing in soil previously

[1] Published with the approval of the Director, Mississippi Agricultural Experiment Station, as Journal Paper No. 148 (N.S.).

treated with 2,4-D at 1,000 ppm appeared normal in every respect. The yield of sweet-potato roots for the treatments that received activated carbon were as follows for the test conducted at Stoneville, Mississippi: Ck, 319 bu; 1,000 ppm, 324 bu; 2,000 ppm, 298 bu; 3,000 ppm, 246 bu; 4,000 ppm, 234 bu. The yields were not definitely affected except in the manner in which 2,4-D influenced plant survival. The weeds were controlled by cultivation in this test. At the same time, this concentration of 2,4-D controlled annual weeds, such as crabgrass (*Digitaria sanguinalis*), pigweed (*Amaranthus retroflexus*), bindweed (*Convolvulus* sp.), spurge (*Euphorbia* sp.), and others, at State College, Mississippi, and in tests on other crops at Stoneville, Mississippi.

TABLE 1

EFFECT OF ACTIVATED CARBON ON THE SURVIVAL OF SWEET POTATOES AT STATE COLLEGE, PLANTED ON LEEPER CLAY SOIL PREVIOUSLY SPRAYED WITH VARYING RATES OF 2,4-D

Free-acid equivalent of 2,4-D		Survival of original planting (%)*	
Concentration of solution (ppm)	Lbs/acre	Activated carbon treatment	Untreated
0	0.0	100.0	93.0
1,000	1.3	95.0	2.5
4,000	5.2	32.0	0.0

* Average of 4 replications; 10 plants per plot; planted May 16, 1947; survival readings taken June 30, 1947.

TABLE 2

EFFECT OF ACTIVATED CARBON ON THE SURVIVAL OF SWEET POTATOES AT STONEVILLE, PLANTED ON SARPY SANDY LOAM PREVIOUSLY SPRAYED WITH VARYING RATES OF 2,4-D

Free-acid equivalent of 2,4-D		Survival of original planting (%)*	
Concentration of solution (ppm)	Lbs/acre	Activated carbon treatment	Untreated
0	0.0	70.0	75.0
1,000	1.3	78.0	5.0
2,000	2.6	70.0	1.7
3,000	3.9	62.5	0.0
4,000	5.2	28.3	0.0

* Average of 3 replications; 20 plants per plot; planted May 27, 1947; survival readings taken July 2, 1947.

The sweet potato plants that survived the heavy (4,000 ppm) treatment were dark green, and some of the leaves showed abnormalities.

The above data indicate that activated carbon may be used to protect certain crop plants against the effect of 2,4-D when the latter has been applied to the soil as a pre-emergence herbicide.

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Studies on Radiosensitivity of Cells[1]

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It has been commonly believed that the sensitivity of mammalian cells to ionizing radiations is proportional to cell activity in terms of mitotic proliferation—the more active the proliferation, the more sensitivity. An increased erythropoiesis can be initiated in the laboratory animal by phlebotomy or by the hemolytic action of acetyl phenylhydrazine on the circulating erythrocytes. These procedures made possible an experiment designed to compare the vulnerability to irradiation of the highly sensitive erythrocyte precursors existing in the normal hemopoietic tissue of rabbits with those in hemopoietic tissue of rabbits which have an induced hyperplasia of erythrocyte precursors (Table 1). The effect of 800 r

TABLE 1

PREPARATION AND TREATMENT OF ANIMALS

Group	Phenylhydrazine subcutaneously	X-ray	No. of animals
Phenylhydrazine Experiment			
I	None	None	10
II	*ca* 35–40 mg	800 r	28
III	None	800 r	16
IV	*ca* 35–40 mg	None	16
Blood Withdrawal Experiment			
V	None	None	10
VI	*ca* 90 cc	800 r	15
VII	None	800 r	15
VIII	*ca* 90 cc	None	10

whole-body X irradiation upon animals that have a previously induced regenerative anemia was compared with the effect of this same dose on normal animals of comparable age and weight. Determinations of the erythrocytes and reticulocytes/cu mm and hemoglobin in grams/100 ml are recorded in Figs. 1, 2, and 3. The normal irradiated animals developed an anemia that reached a maximum at 14 days. The animals in which a regenerative anemia had been produced prior to irradiation with

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[2] With the Argonne National Laboratory and Department of Medicine, University of Chicago.

[3] Senior Research Fellow of the U. S. Public Health Service, University of Chicago.

800 r developed no further anemia. The recovery time in both groups was comparable (23 days). The mean reticulocyte value of the phenylhydrazine-injected, X-rayed animals was reduced below the normal control

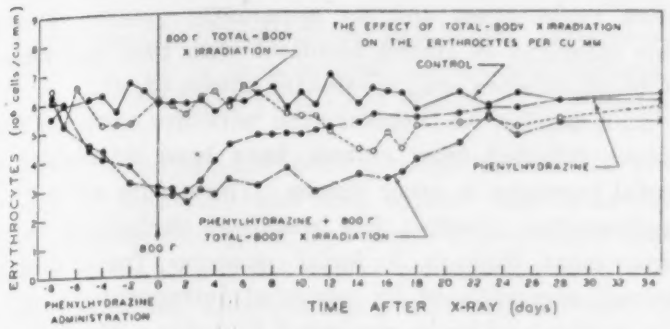

FIG. 1

value on the 6th postirradiation day only. The phlebotomized group of animals responded to irradiation in a manner comparable to the animals treated with phenylhydrazine and X-ray.

The histologic studies made on appropriately sacrificed animals revealed that erythropoietic tissue in the bone

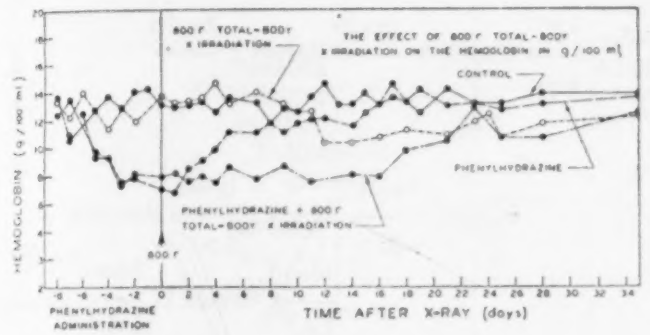

FIG. 2

marrow and the spleen was essentially completely destroyed by 3 days in normal animals receiving 800 r. A relatively slow recovery ensued beginning on the 7th to the 9th day. On the other hand, the erythropoietic tissue in the bone marrow and spleen was only partially

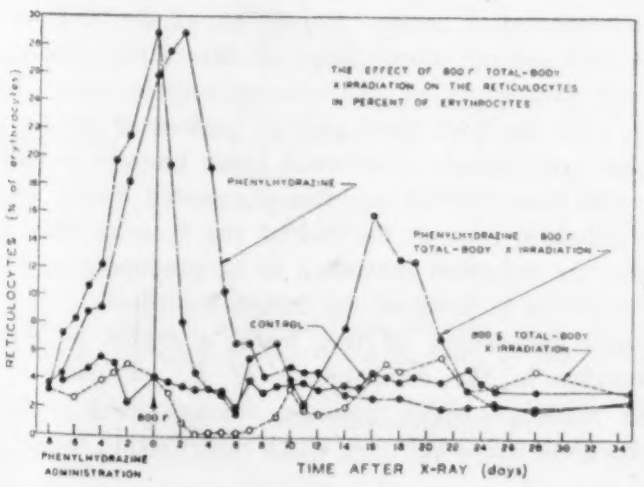

FIG. 3

destroyed in animals irradiated with 800 r after a regenerative anemia was produced by phenylhydrazine or phlebotomy (Fig. 4). Sufficient viable erythropoietic tissue remained to permit an essentially normal production of erythrocytes.

These data would tend to indicate that erythroblast vulnerability to irradiation injury is not enhanced by increased mitotic activity and proliferation. In fact, the hyperplastic erythroid tissue sustained less histologic injury than the normal, and the production of erythrocytes was maintained. Since the erythroblasts in hyperplastic and in normal tissue received the same dose of radiation, the completeness of destruction should have been comparable in the two experimental setups unless differences

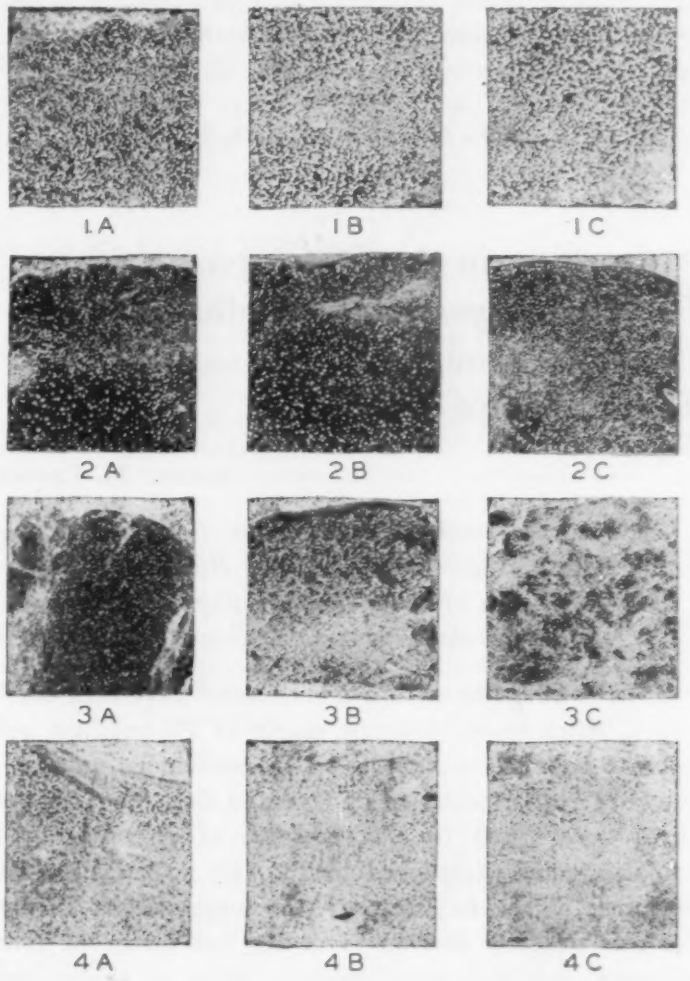

FIG. 4. The hematologic effects of 800 r on normal and hyperplastic bone marrow of the rabbit: 1A, B, C—range of normal control marrow; 2A, B, C—bone marrow after phenylhydrazine-induced hyperplasia 3, 4, and 6 days, respectively, after phenylhydrazine withdrawal; 3A, B, C—bone marrow of phenylhydrazine-induced hyperplasia at 1, 3, and 5 days, respectively, after 800 r and 3, 4, and 6 days, respectively, after phenylhydrazine withdrawal; 4A, B, C—bone marrow of normal rabbits exposed to 800 r at 1, 3, and 5 days after 800 r. (Mag. 16 ×.)

in sensitivity to radiation existed. One factor which may have caused this apparent difference in sensitivity is that a larger number of basophilic and polychromatophilic erythroblasts was present in the hyperplastic tissue than in the normal tissue at the time of irradiation. It was largely these cells that survived and were immediately capable of mitotic proliferation. Actually, any attempt to explain differences in radiosensitivity of cells involves factors concerned in the metabolism of cells which we do not understand at the present time.

It has been reported that the reduction of blood flow

to a lymph node, and thus a reduction in oxygen supply to the node, reduces the sensitivity of the lymphocytes therein to irradiation (*1*). Reduced oxygen tension, however, does not "stimulate" lymphocyte production. The production of anemia in the experimental animal by phlebotomy or phenylhydrazine administration by virtue of reducing the oxygen supply to the bone marrow produces a stimulus, an optimum condition, for the proliferation of erythroblasts. The mechanism for the reduced radiosensitivity in the lymphatic tissue with O_2 deprivation is probably different from that operating in erythropoietic tissue in the presence of an anemia.

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Alterations in the Development of *Plasmodium gallinaceum* Following Passage Through Tissue Culture

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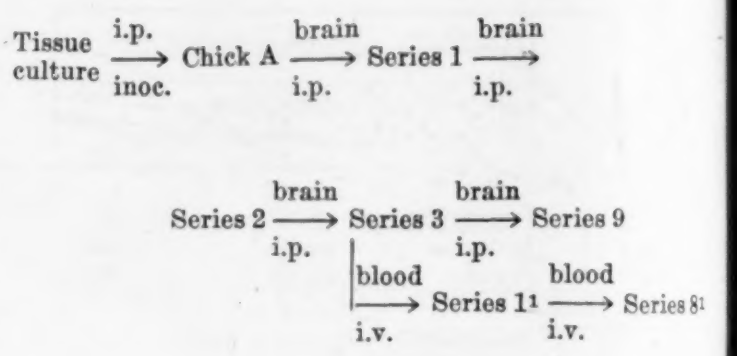
A series of tissue culture experiments[2] have been carried out in which exoerythrocytic stages of *Plasmodium gallinaceum* have been maintained in continuous culture by the roller tube technique of Gey and Gey (*1*). The cultures were tested for the presence of parasites by inoculating chicks intraperitoneally with material from the cultures. The majority of the experiments involved colonies of cells derived from the pia mater of blood-infected, quinine-treated chicks. Some of the cultures, however, had been derived from heart muscle of such birds. Each of the cell strains was subcultured at intervals which varied with the rate of growth of the tissue-cultured host cells. Microscopical examination of such cultures failed in most instances to reveal extensive development of parasites. Nevertheless, young chicks receiving inoculations from cultures which had been maintained for four or five subcultures, and which were as much as 70 days old, became infected with *P. gallinaceum*.

The primary purpose of this preliminary paper is to emphasize the peculiar character of the resulting infection in chicks, since this has been exclusively of an exoerythrocytic nature. Chicks infected as indicated above ranged from 7 to 32 days old. They invariably developed an overwhelming exoerythrocytic infection which terminated fatally 10–17 days after their inoculation with material from culture. No pigmented erythrocytic stages developed in any of the birds, although, in several instances, at the time of death a low percentage (1–3%) of the erythrocytes were parasitized with minute, unpigmented, uninuclear forms. With the exception of a more rapid onset and an apparently greater severity, this infection is almost identical with that encountered in blood-infected, quinine-treated chicks (*3*, *4*).

In a number of instances the parasites obtained from chicks infected from culture have been maintained by serial passages in other chicks. The nature of this exoerythrocytic infection has remained unchanged in one experiment through 9 serial passages (note diagram below) accomplished by means of intraperitoneal inoculation (i.p.) of brain suspended in saline. The infection in birds 2–35 days old continues to be acute, with exoerythrocytic parasites readily demonstrable in the capillary endothelium of the brain as early as 4 days after inoculation. Death from exoerythrocytic parasitism has occurred as early as 6 days after inoculation with infected brain material.



In contrast to the above, serial passage of the infection by intravenous inoculation of blood from such birds resulted in a somewhat different picture of parasitism. For example, blood taken from chicks of the previously mentioned series (see diagram) was used to initiate a blood inoculation series. Parasitism of the birds of the first and second inoculations of this series was again almost exclusively of the exoerythrocytic type. However, after the third blood passage pigmented erythrocytic stages were found. Continued blood passage seemed to increase the number of the pigmented blood stages. Nevertheless, even at the end of the 8 serial blood passages, the infection continued to be preponderantly exoerythrocytic in most of the infected birds.

Since completion of this work, a report of similar alteration in the development of *P. gallinaceum* has been made in which passage through chick embryos, rather than tissue cultures, was a contributing factor (*2*).

[1] The author wishes to express his appreciation for the assistance and advice which G. F. Otto, of the Department of Parasitology, and G. O. Gey, of the Division of Cellular Physiology, have given during the course of this investigation.

[2] To be reported on at a later date.

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Dehydroascorbic Acid in Frozen and Cooked Frozen Vegetables[1]

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Recently, attention has been directed toward the importance of analyzing raw and cooked vegetables for dehydroascorbic acid (*2, 4, 6*). Since it is possible that dehydroascorbic acid forms during preparation for freezing procedures and frozen-storage, it seemed of value to determine the dehydroascorbic acid content of vegetables in the fresh, scalded, and frozen-stored states. The frozen-stored vegetables were also analyzed after cooking to determine the net result of these procedures on the various forms of ascorbic acid.

Chard, spinach, peas, snap beans, and lima beans were used for these studies. Representative samples, unscalded and scalded, were frozen and stored at 0° F for 6 months. Twenty-five–gm aliquots of the frozen-stored vegetables were cooked in 50 ml of distilled water, cooled immediately, and the total sample blended. Reduced ascorbic acid was determined by the method of Loeffler and Ponting (*3*); dehydroascorbic acid, by the Bolin and Book modification (*1*) of the Roe and Oesterling method (*5*). Typical data are presented in Table 1.

A significant amount of dehydroascorbic acid was found in the fresh vegetables. This was markedly decreased by scalding, but increased again during frozen-storage. Cooking the frozen vegetable almost completely destroyed the dehydroascorbic acid present. In both the scalded and cooked, frozen vegetables, the dehydroascorbic acid content represented 12% or less of the total ascorbic acid, with the exceptions of unscalded spinach and chard, where the total ascorbic acid content was very low.

The dehydroascorbic acid accounted for an appreciable part of the reduced ascorbic acid lost during frozen-storage in both scalded and unscalded vegetables. In the unscalded raw samples, the dehydroascorbic acid represented from 22 to 94% of the total ascorbic acid content, and in the scalded raw samples, 15 to 44%. However,

TABLE 1

Ascorbic Acid Content of Frozen and Cooked Frozen Vegetables

Vegetable	Ascorbic acid*	Fresh	Scalded†	Frozen, stored 6 mos			
				Unscalded		Scalded	
				Raw	Cooked‡	Raw	Cooked‡
				mg/100 gm			
Chard	Reduced	52.1	35.4	1.6	1.3	13.4	12.4
	Dehydro	7.7	1.6	19.0	1.1	10.6	1.6
	Total	59.8	37.0	20.6	2.4	24.0	14.0
	Dehydro, % of total	13	4	92	46	44	11
Spinach	Reduced	78.9	41.7	0.6	0.6	20.4	14.6
	Dehydro	3.8	1.7	9.2	0.6	6.8	1.4
	Total	82.7	43.4	9.8	1.2	27.2	16.0
	Dehydro, % of total	5	4	94	50	25	9
Peas	Reduced	25.3	20.5	9.1	9.2	17.6	15.0
	Dehydro	3.9	1.4	5.6	1.3	3.1	1.2
	Total	29.2	21.9	14.7	10.5	20.7	16.2
	Dehydro, % of total	13	6	38	12	15	7
Snap beans	Reduced	29.6	28.6	12.6	11.6	17.2	15.7
	Dehydro	4.7	0.8	12.7	1.5	6.5	1.7
	Total	34.3	29.4	25.3	13.1	23.7	17.4
	Dehydro, % of total	14	3	50	11	27	10
Lima beans	Reduced	27.9	17.9	20.3	16.9	17.0	12.8
	Dehydro	5.5	2.5	5.7	1.3	3.2	1.5
	Total	33.4	20.4	26.0	18.2	20.2	14.3
	Dehydro, % of total	16	12	22	7	16	10

* Ascorbic acid values calculated back to the fresh, raw basis.
† Chard, spinach, and lima beans scalded 2 min: peas, 1½ min: snap beans, 3 min.
‡ Chard and spinach cooked 5 min; peas, 10 min; snap beans and lima beans, 15 min.

[1] Published as Scientific Paper No. 744, College of Agriculture and Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington.

since it is destroyed during cooking, analyzing for dehydroascorbic acid in these frozen-stored raw vegetables seems of questionable value.

Further studies are being made on the factors affecting the conversion of reduced to dehydroascorbic acid and the loss of total ascorbic acid during frozen-storage.

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On the Infrared Spectra of Nucleic Acids and Certain of Their Components[1]

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The fact that nucleoproteins and nucleic acids are important constituents of tissue and take part in many cellular processes has been recognized for some time. Chemical methods for the identification of these substances and their components (nucleotides, nucleosides, purines, pyrimidines, and sugars) have been devised, but are characterized by their complexity.

Since all the nucleic acids are colorless, optical methods are limited to either (a) combination of the nucleic acid with an absorbing substance (*3*) by either adsorption or reaction or (b) investigation of the extravisible regions of the spectrum. Several careful studies of the ultraviolet absorption of nucleic acids (*1, 2, 4*) and their component purines and pyrimidines (*4, 5*) have been reported. Unfortunately, in the readily accessible region of the ultraviolet (210–400 mμ) the only components of nucleic acids which absorb are the purine and pyrimidine bases, and these do so over a relatively narrow spectral range. Thus, although the estimation of one particular purine or pyrimidine in the presence of others by ultraviolet spectrometry is possible if their spectra are sufficiently different (*6*), it is very difficult, if not impossible, when their spectra are similar, as in the cases of thymine, uracil, and adenine. It is, of course, not possible by this method to determine anything about the nature and amount of the other components of nucleic acid, namely, the sugars and phosphoric acid.

In this paper we report preliminary results on the determination of infrared absorption in the region 700–1,800 cm^{-1} of yeast ribonucleic acid, thymus desoxyribonucleic acid, and some of their chemical constituents. The lack of solubility of these materials in other than aqueous solvents makes it necessary to determine the spectra in the solid phase. Three methods have been used: (a) films evaporated in high vacuum onto sodium chloride plates, (b) finely ground powder layers between sodium chloride plates (*7*), and (c) continuous films cast onto silver chloride plates. Fig. 1 summarizes the data, showing the positions of the principal absorption bands as lines (the height indicating the relative intensities) and the physical state in which the measurement was made.

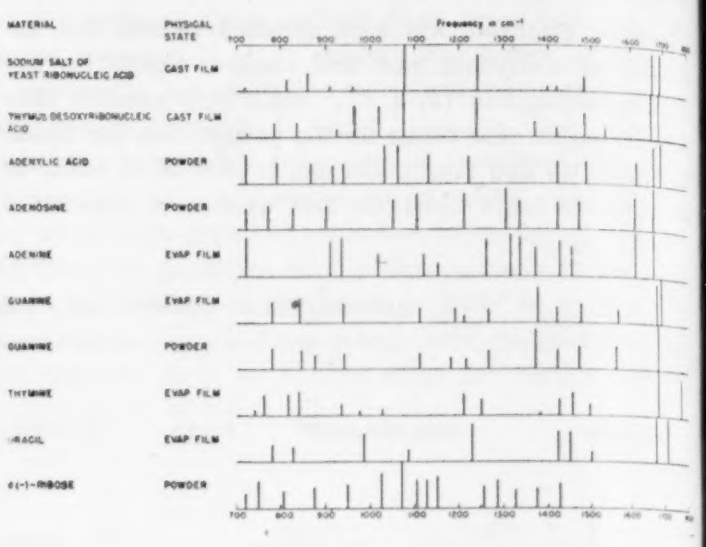

Fig. 1

Obviously, with such complicated molecules it is impossible to give definite assignments to all the absorption bands. It seems possible, however, to correlate several of the bands with particular atomic groupings, especially when many closely related compounds have been studied. It is certainly possible to differentiate one pure material from another by means of their infrared spectra. Thus, for example, by infrared spectroscopic methods it is possible to differentiate ribonucleic acid from desoxyribonucleic acid by means of their absorptions at frequencies lower than 1,100 cm^{-1}, thymine (6-methyl uracil) from uracil and adenine on the basis of their absorptions between 900 and 1,200 cm^{-1}, and, in fact, to detect thymine and uracil in mixtures. This suggests the possibility of differentiating between nucleic acids from different sources.

It is hoped that this approach can be extended to the study of nucleoproteins, nucleic acids, and their degradation products extracted from normal and neoplastic tissues. Complete details of the above spectra and other related compounds will be published elsewhere.

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IN THE LABORATORY

Radiocarbon and Filter-Paper Partition Chromatography[1]

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Experiments with radioiodine, I^{131}, (*3*) indicated that filter-paper partition chromatography might be a very useful tool in biological studies with radioisotopes. In order to determine whether the procedure could be used profitably with radioactive elements showing a more general distribution and a less penetrating radiation, an experiment was carried out with radiocarbon, C^{14}.

One mg of *Chlorella* suspended in 0.1 ml of distilled water was exposed to light in the presence of 2 ml of air containing a few micrograms (1 μc) of radioactive carbon dioxide for a period of 4 hrs, and the tube containing the *Chlorella* was then connected with a tube containing solid KOH for an additional hour. The *Chlorella* suspension was divided into two equal portions, one of which was hydrolyzed in 0.1 ml of 6 N HCl for 24 hrs, and the other centrifuged and extracted with 25 μl of hot 80% alcohol for 30 min. A two-dimensional chromatogram of each of the solutions (plus added amino acid markers) was developed with phenol and collidine,[3] and after the filter papers were dry, they were pressed directly against sensitive X-ray film (E.K. "No Screen") for three days. The alcohol extract gave an excellent chromatogram, the radioautograph of which showed exposed areas as follows:

(1) A rather poorly defined very dark spot or spots due to relatively fat-soluble radioactive substances, possibly organic acids of low volatility, which had traveled essentially with the boundary in both phenol and collidine.

(2) A dark spot in approximately the position taken by glucose in routine chromatograms (R_F values of 0.42 and 0.41 in phenol and collidine, respectively).

(3) A moderately dark spot coinciding in position with the glutamic acid added as a marker.

(4) Light spots coinciding in position with the glycine, alanine, arginine, valine, and proline added as markers.

(5) Light spots tentatively identified as aspartic acid, serine, and threonine; two light spots near glycine and two near alanine which could be sugars or peptides; and an unidentified light spot with R_F values of 0.98 and 0.06.

There was no visible exposure in the area occupied by the phenylalanine added as a marker or in the positions ordinarily taken by the amino acids not listed above.

A chromatogram prepared from an 80% alcohol extract of 200 mg of nonradioactive *Chlorella* caused no "chemical exposure" of an X-ray film and, when treated with ninhydrin, showed spots tentatively identified as aspartic acid, glutamic acid, serine, glycine, threonine, alanine, histidine, and arginine, and an unidentified spot with R_F values of 0.10 and 0.05.

Due to a marked temperature change during development, the chromatogram prepared from the *Chlorella* hydrolysate was skewed to such an extent that detailed identifications could not be made. However, it appeared similar to the alcoholic extract chromatogram except for a general increase in the amino acid radioactivity, so that glutamic acid apparently was about as radioactive as the fatty substances, while the other radioactive amino acids present contained amounts of C^{14} similar to that in the spot tentatively identified as glucose.

Reduction in sensitivity of the radioactive measurements due to absorption of the soft C^{14} beta ray in the filter paper appeared to be of moderate degree. A thin-window Geiger counter capable of recording 30% of the beta particles from a thin layer of $BaC^{14}O_3$ counted 10% of the disintegrations from the C^{14} in a filter paper spot. The areas of the filter paper which produced light spots on the radioautograph could hardly be differentiated from the blank areas with an unshielded counter.

These experiments appear to be convincing evidence that an extremely valuable tool for intermediary metabolism studies with radioisotopes is at hand. With the possibility of preparing filter paper chromatograms of moderately water-soluble compounds of low molecular weight, such as amino acids (*1*), sugars (*5*), organic acids (*4*), purines (*6*), peptides (*2*), and a variety of other organic and inorganic substances (*2*), a considerable amount of data concerning the metabolic fate of radioactive compounds may be obtained by a very simple procedure. A particularly valuable feature of the chromatographic technic is its ability, without any deviation from the routine procedure, to isolate and draw attention to unexpected or even unknown compounds involved in a metabolic process under study and, in addition, to aid considerably in their identification.

The lower limit to the quantity of any given compound which may be handled successfully by partition chromatography seems to be determined, in general, by the

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[2] Present address: Birmingham Veterans Administration General Hospital, Van Nuys, California, and the University of California, Los Angeles. The authors wish to thank Albert Frenkel for furnishing the *Chlorella* and W. F. Bale and A. H. Dowdy for their interest and encouragement in this work.

[3] The mixture referred to as collidine in this description was actually the organic phase from a mixture of 1 part 2,4,6-collidine, 1 part 2,4-lutidine, and 2 parts H_2O, as recommended to us by C. E. Dent.

sensitivity of the procedure employed for detecting the spots. With most good visual color reactions this lower limit is in the order of 1 μg (and frequently embarrassingly close to the upper limit), but with radioactive compounds of high specific activity quantities many orders of magnitude smaller may be easily detected, identified, and isolated in a small volume of solvent for further tests. Due to the limited top capacity of the filter paper (upper limit generally in the order of 10^{-4} gm of any single compound) and the consequent desirability of obtaining high specific activity in the radioactive metabolites, microorganisms which are resistant to radiation damage would seem to be the most suitable subjects for study by the procedure outlined. The present results indicate, however, that application of the technic to short-term experiments with small animals may be practical, since radioisotope doses of the order of 10^{-5} c/gm of tissue should be adequate for most purposes. Work is continuing to test the feasibility of obtaining data concerning the mechanisms of biological conversions by preparing a sequence of chromatograms at various periods after administration of an isotopic substance to show the order and rate at which various radioactive spots appear and fade. Preliminary data and calculations also indicate that it may be possible to use the chromatograms as a means of isolating radioactive intermediates for use in further metabolism experiments on a proportionately smaller scale.

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Quantitative Determination of Carbohydrates With Dreywood's Anthrone Reagent

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Roman Dreywood recently described a reagent for carbohydrates which is simpler to prepare and use than any of the standard reagents (*1*). Moreover, its specificity for carbohydrates is very high. Dreywood suggested that the reagent might be of value for quantitative determinations and has actually used it for the determination of cellulose and starch.[1]

The specificity that Dreywood claimed for the reagent has been fully confirmed in this laboratory: it has given a positive reaction with all pure mono-, di-, and polysaccharides tested, as well as with all samples of dextrins, dextrans, starches, and plant polysaccharides and gums. Positive reactions were also obtained with pneumococcus polysaccharides of types II and III (but not type I), with all glucosides tested, and with the acetates of mono-, di-, and polysaccharides. No noncarbohydrates tested gave the characteristic blue color; a red color was produced by polyvinyl alcohol and by proteins. The common solvents gave no color, though solutions containing dioxane became fluorescent. The sugar alcohols likewise produced no color.

For a quantitative reagent, 2 gm of anthrone[3] is dissolved in 1 liter of 95% sulfuric acid (prepared by the cautious addition of 1 liter of concentrated sulfuric acid to 50 ml of water, and cooling). Four or 5 ml of the solution to be determined is measured into a test tube of 19- to 25-mm diameter, and 8 or 10 ml of the reagent added. The solutions are at once thoroughly mixed by swirling. After 10 min or more, the color is measured either in an electrophotometer against a blank containing only water and reagent or in a visual colorimeter against a glucose standard. The color varies with the amount of carbohydrate, in accordance with Beer's law, if color filters of 540 mμ (green) or 620 mμ (red) are used. The latter has been found preferable, since it gives higher sensitivity and decreases any errors caused by extraneous colors.

Inasmuch as the reaction is brought about by the heat developed when the reagent and water solutions are mixed, the shape and size of the reaction tube are important. Less color develops with a given amount of sugar in either small (less than 15-mm diameter) or very large tubes, and this error is greater at higher sugar concentrations. This is presumably due to the cooling of the solution before the reaction is finished. Use of small volumes of solution has the same effect. Thus, if a Klett-Summerson colorimeter is to be used, the reaction must be carried out, as described, in 19- to 25-mm tubes, and the solution poured into the Klett tubes just before the readings are made.

Fig. 1 shows absorption curves for glucose, measured with three different filters, in an Evelyn photoelectric colorimeter, with the use of 4 ml of the sugar solution and 8 ml of the reagent. Under these conditions the practical range is from about 8 to 200γ of glucose with the 620 mμ filter, and from 20 to 500γ with the 540 mμ filter. It is clear that the filter at 660 mμ cannot be used. In this laboratory only the 620-mμ filter is used.

[1] Personal communication.

[2] Obtained through the kindness of Dr. Michael Heidelberger.

[3] For convenience, there follows a condensed outline for the preparation of anthrone (*2*). A mixture of 104 gm of anthraquinone, 100 gm of granulated tin, and 750 ml of glacial acetic acid is heated to boiling under reflux. Over a period of 2 hrs, 250 ml of hydrochloric acid (sp. gr., 1.19) is added. The hot solution is then filtered through sintered glass, and 100 ml of water added. The mixture is cooled to 10°, and the precipitated anthrone filtered off with suction and washed with water. The crude product (about 80 gm) is dissolved in warm benzene (8–9 ml/gm), and 1/3 volume of petroleum ether is added. The anthrone that crystallizes is filtered off and air-dried. The yield is about 60 gm.

The reagent darkens in the course of time, and there is a shift in the position of the absorption curves. The curves obtained with the 620-mμ filter remain linear, however, even after a month (by which time the solutions are so dark that measurement is exceedingly difficult). In practice, the reagent may be used for 4 or 5 days with either the 540- or 620-mμ filter. The aging of the reagent precludes the use of a standard calibration curve, and hence a known sugar standard must be included with each series of unknowns. Alternatively, fresh reagent may be prepared daily.

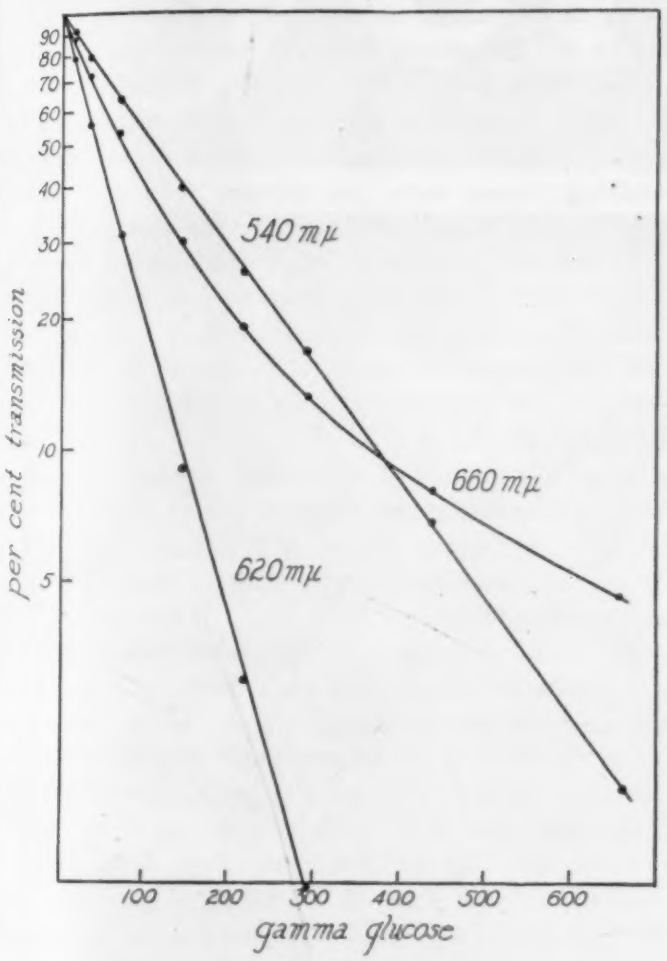

FIG. 1

The calculation of results will depend on the type of colorimeter used. In the case of the Klett type of instrument, the sugar concentration is directly proportional to the dial reading. With the Evelyn type, where readings are in per cent transmission, results can be plotted on semilogarithmic paper as in Fig. 1, or calculations can be done with a slide rule.[4]

Duplicate determinations rarely vary by more than 2% from the mean. Greater errors than this can usually be ascribed to dirty tubes, lint from filter paper, etc.

The reagent is remarkable in that the same depth of color is given by a compound of a sugar as if the compound were first hydrolyzed and the sugar then determined. Thus, for 100γ amounts of each, glucose gives a value of 100γ; maltose, of 105γ; and glycogen, of 111γ. Duplicate samples of glycogen, determined before and after hydrolysis with 1N sulfuric acid at 100° C for 3 hrs, give identical colors. Equal amounts of glucose and fructose give identical colors, and 100γ of sucrose is equivalent to 105γ of glucose. Similarly, 100γ of α-methyl glucoside gives a value of 93γ (theoretical 93), and 100γ of glycogen triacetate, a value of 61γ (theoretical 62.5). (This compound was dissolved in 0.2 ml of acetone, and 3.8 ml of water was added just before the reagent.) Galactose gives much less color than glucose: 100γ gives a reading corresponding to 54γ of glucose. Lactose hydrate (100γ) gives a value of 77γ as glucose; this would be predicted from the 50γ of glucose and 50γ of galactose in the sugar.

The reagent has been used with success in this laboratory for the determination of glucose in blood and lactose in milk, glycogen in blood and liver, carbohydrates in urine, etc. In cases where the amount of carbohydrate is not too small, compared with the extraneous material, the determinations may be exceedingly simple. Thus, lactose in milk can be determined after simple dilution of the whole milk; the result obtained is the same as that found after deproteinization of the milk. Glycogen determinations are greatly simplified, since acid hydrolysis can be omitted. Detailed data on some of the determinations just mentioned will be published later.

[4] The logarithm of I_o/I can be read directly on the *log* scale of the slide rule opposite the transmission on the *CI* scale. This logarithm is directly proportional to the sugar concentration.

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Improved Assembly of the Hartung-Clark Double Cannula for the Isolated Frog Heart

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In 1911, Hartung (*4*) first described a double cannula for perfusion of the isolated frog heart which he used in an extensive study of aconitine. A slight modification of the same arrangement was used in 1912 by A. J. Clark (*2*) in his studies of digitalis and of metabolism and electrical responses of the heart. The arrangement used by Clark and its adaptation to various purposes has been described and illustrated (*3*).

After some usage of a double cannula arrangement[2] in demonstration exercises for students and in research on cardiac drugs in this department, it has seemed that this method, further improved, has merits that other more complicated (*1, 6*) or uncontrolled (*5*) methods do not.

[1] Fellow, American Bureau for Medical Aid to China, Inc. The author wishes to thank P. J. Hanzlik for suggestions and continued guidance.

[2] A similar cannula, but without the improvements described in this paper, was first demonstrated in this department by F. P. Ludueña, now with the Sterling-Winthrop Research Institute, Rensselaer, New York.

The illustrations in Fig. 1 show the aortic cannula (a), venous reservoir (b), and automatic overflow tubes (c), drawn to scale. The dimensions of the different parts are as follows: over-all length of aortic cannula, 7 cm; height to bend, 4 cm; spread from tip to vertical portion, 3.3 cm; internal diameter, 3 mm (constriction, 2 mm); over-all length of venous reservoir, 6.5 cm; internal diameter at top, 1.5 cm; length of side tube, 1 cm; diameter, 3 mm; length of overflow tube, 2.5 cm; diameter, 2 cm; length of inside straight tube, 3 cm; diameter, 3 mm; length of inside bent tube, 2 cm; diameter, 3 mm. The latter is connected by a rubber

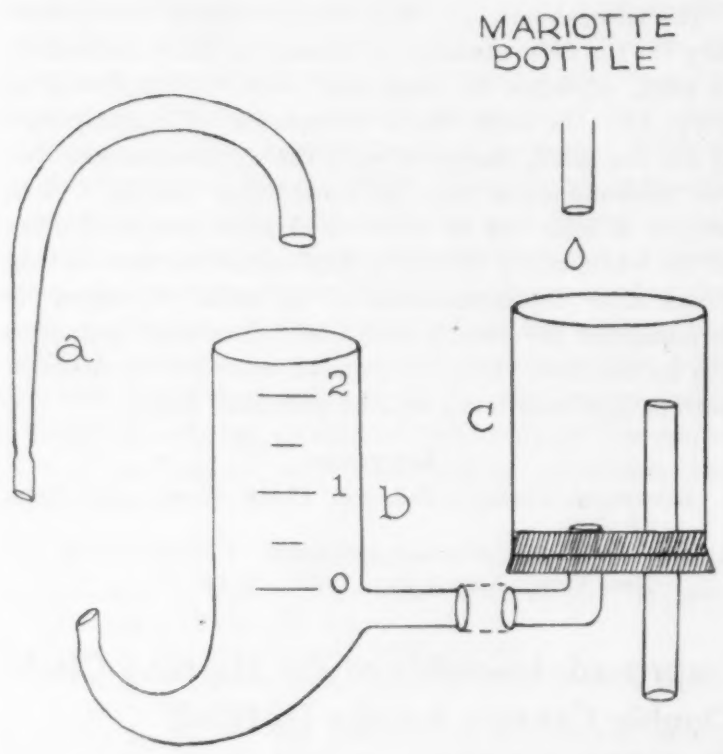

FIG. 1. Improved assembly of the Hartung-Clark double cannula for the isolated frog heart. The aortic cannula and venous reservoir and extensions for these are obtainable from Frank H. Osborn, 564 Howard Street, San Francisco 5, California.

tube (about 10 cm long) to the side tube on the venous reservoir. A rubber stopper is used for holding the tubes in the overflow tube, which is conveniently fixed to an iron stand with a clamp and adjusted to obtain the desired fluid level in the venous reservoir. A Mariotte bottle is placed conveniently on a top shelf for continuous dripping of Ringer's solution into the overflow tube. For observing drug action under changed pressures, convenient extensions for the aortic cannula are three pieces of the same glass tubing—2-cm proximal cannula end, 5-cm arc, and 9.5-cm length with arc, the maximum length permissible being 20 cm when cardiac embarrassment occurs. A piece of tubing about 4.5 cm in length and with 1.5-cm internal diameter is provided for joining (with a suitable rubber band cut from tubing) to the venous reservoir.

Checks were made on many hearts to justify the choice of the various parts used in this arrangement. A pressure of 2 cm of Ringer's fluid in the venous reservoir gave the most constant optimum performance, according to stroke output, minute output and rate, for the longest period (2 hrs) without auricular distention, confirming Clark (*3*). Departures from this pressure impaired the cardiac functional efficiency.

Frogs of 100- to 250-gm body weight are preferred for the improved double cannula. The frog is pithed first and the heart exposed. After the pericardium is opened, the right aortic arch and both superior vena cavas are ligated. Next, the frenum ligament is cut and a double silk thread passed under the inferior vena cava, after which the distal end of the venous reservoir is inserted and tied in just short of the sinus venosus, whose functioning should remain unimpaired. A few cc of Ringer's solution are introduced into the reservoir to empty the heart of blood and prevent clotting; this is also a check on correct insertion of the reservoir. Next, the aortic cannula is placed, all ligated vessels are cut away, the remaining thread under the inferior vena cava is tied, all pulmonary vessels are ligated, and the heart is removed and the cannulas mounted with suitable clamps on an iron stand. After any necessary adjustment of the cannulas, especially the aortic, which lifts the heart to allow free contraction of the sinus tissue, the circulation is started and the level of fluid in the venous reservoir adjusted with the aid of the overflow tube to secure optimum functioning of all cardiac chambers. The external surface of the heart should be kept moist by means of a slow, continuous drip of Ringer's solution. In this way the suspended heart may remain in good functioning condition for 12 hrs.

The chief advantages of the arrangement here described may be summarized as follows: (1) It may be used as a closed circulating system, or for continuous perfusion, without special aeration. (2) Perfusion (or venous) pressure is kept practically constant, regardless of changing conditions such as rate of flow, washing, measurement of stroke or minute output from the aortic cannula (with the aid of a trough of thin aluminum under the tip). (3) It allows ready change of pressures to desired levels. (4) With a tuberculin syringe (0.25-cc capacity for high concentrations) it permits easy drug application direct to venous reservoir (when closed circuit is used). (5) Fluid may be removed quickly from the venous reservoir with a medicine dropper. Ventricular volume is readily recorded by applying a small glass cardiometer (Camus type, *1*) with soft-rubber dam and small tambour recorder. Harvard heart levers are used for recording the activity of the ventricle or auricles, or both, on a kymograph.

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